Deutsche Bank
Group

26 January 2011

LiB materials industry

Automotive LiB materials get set for growth phase in 2011

FITT Research

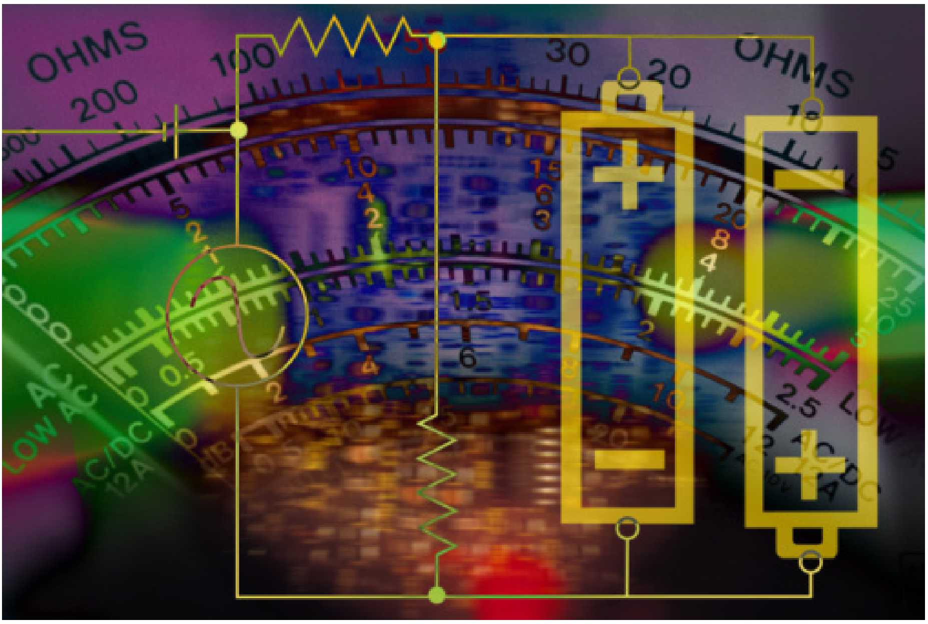
Fundamental, Industry, Thematic, Thought leading
Our Equity Research Department's Stock Selection Committee has recognized this report as being rich in unique investment ideas and as meeting its "FITT" (Fundamental, Industry, Thematic, Thought leading) criteria for investors. We think automotive LiB materials, which are viewed as having significant growth potential, are likely to become widespread from around 2012, with the turning point set to begin in 2011. To present a comprehensive outlook, we also focus on related industries from a long-term perspective.

Fundamental: Market for automotive LiB materials to top ¥900bn in 10 years

Industry: Still premature to see Korean or Chinese companies as threats

Thematic: New non-automotive applications (i.e. energy storage systems)

Thought leading: Mitsubishi Chemical HD provides all four main LiB materials



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Japan
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Fundamental: Market for automotive LiB materials to top ¥900bn in 10 years

We estimate that the market for LiB materials stood at over ¥280bn in 2009, with the majority of materials used in consumer products and an almost negligible amount in automotive applications. We expect growth for new types of portable digital devices and for new applications (e.g. storage batteries) to support solid long-term growth for LiBs in the consumer-product and energy areas. However, we also look for auto-use LiB materials to exhibit strong growth in or around 2015, when this market could be worth just over ¥220bn. Furthermore, we think LiB materials for automotive use will exceed that of materials for consumer products around 2017, and look for market growth to stabilize around 2020, when we estimate its value at roughly ¥920bn.

Industry: Still premature to see Korean or Chinese companies as threats

Japanese battery makers are facing an increasingly difficult environment as Korean and Chinese companies are using low prices to expand their share of the consumer-product market. Meanwhile, Korean makers Samsung SDI, LG Chem and SK Innovation are targeting the automotive market. Despite these threats, however, we think LiB materials companies can boost earnings only by offering differentiated, high-quality materials, irrespective of their focus (automotive or consumer) or changes in market share by battery manufacturers. This was the case with electronic materials for semiconductors and LCDs. We thus do not think Japanese LiB materials makers will be directly affected by what some observers view as the Korean and Chinese threat. The high technological barriers to entry in the automotive LiB materials market suggest that Japanese companies with a lead in this area are likely to outflank later entrants.

Thematic: New non-automotive applications (i.e. energy storage systems)

We expect new applications and markets to emerge as battery technology makes larger-capacity LiBs possible. Beyond automotive applications, we see substantial long-term potential for LiBs to store energy obtained by new forms of power generation. For example, because solar-power and wind-power generators cannot store the energy they create, storage devices are needed. We expect LiBs use in these storage devices to expand as these batteries are lightweight and compact.

Thought Leading: Mitsubishi Chemical HD provides all four main LiB materials

Among the stocks we cover, we forecast that Asahi Kasei (leader in separators) and Hitachi Chemical (top share for anode materials) will continue to lead the industry. We expect these companies to develop competitive consumer-product applications for LiB by leveraging their technological edge. Mitsubishi Chemical HD, which is aggressively increasing capacity, is the only global maker of all four main LiB materials, and we expect it to offer custom-tailored solutions in automotive applications. We also focus on Toray, which is trying to increase its market share for automobile battery separators.

Valuation and risk

Our TP calculations differ by company but are based on 1) the average P/E for listed LCD/semiconductor materials and petrochemicals companies, factoring consensus estimates and our forecasts, and 2) average historical P/Es for individual synthetic fiber related companies. Risks for LiB materials companies are 1) a slowdown in Asia, 2) a sharp downturn for new portable digital equipment (smartphones, tablet PCs), 3) slow growth for automotive applications, and 4) a stronger yen.

FITT Research

Top picks	
Mitsubishi Chem. Holdings (4188.T),¥591	**Buy**
Asahi Kasei (3407.T),¥571	**Buy**
Hitachi Chemical (4217.T),¥1,777	**Buy**
Toray Industries (3402.T),¥549	**Buy**

Companies featured			
Mitsubishi Chem. Holdings (4188.T),¥591			**Buy**
	2010A	2011E	2012E
EPS (¥)	9	60	67
P/E (x)	42.3	9.9	8.8
EV/EBITDA (x)	9.3	5.3	4.7
Asahi Kasei (3407.T),¥571			**Buy**
	2010A	2011E	2012E
EPS (¥)	18	46	52
P/E (x)	25.2	12.5	10.9
EV/EBITDA (x)	5.6	4.5	3.9
Hitachi Chemical (4217.T),¥1,777			**Buy**
	2010A	2011E	2012E
EPS (¥)	113	127	142
P/E (x)	15.3	14.0	12.5
EV/EBITDA (x)	5.0	4.6	4.1
Toray Industries (3402.T),¥549			**Buy**
	2010A	2011E	2012E
EPS (¥)	-10	27	34
P/E (x)	–	20.1	16.0
EV/EBITDA (x)	10.9	8.3	7.2

Contents

Introduction

Automotive LiB material to begin growth phase

Progress to reach milestone in 2012

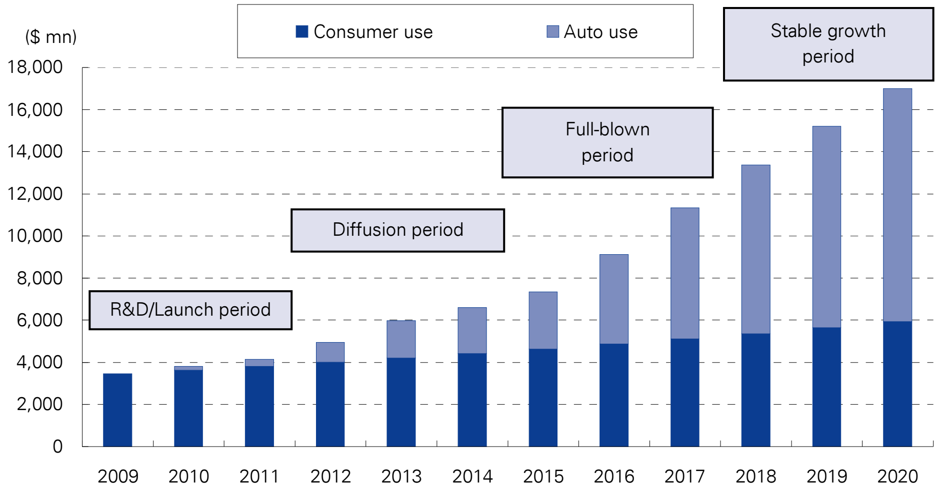
We consider this a critical period for gauging the outlook of lithium ion batteries (LiB) for automobiles, which we see as having high growth potential in 2011-12. We see four stages of growth in automotive LiB materials over a 12-year period (2009-20): (1) R&D and launch, (2) diffusion, (3) full-blown expansion, and (4) stable growth. The 2011-12 period represents the transition from the R&D and launch phase to the diffusion phase. We believe that shipments of automotive LiB materials will expand gradually starting in or around 2012. In other words, this is a pivotal phase for automotive LiB.

Full-blown expansion in automotive LiB materials from 2015

We estimate the market size for major LiB materials (cathodes, anodes, separators, electrolyte solutions) at nearly $3.5bn (around ¥280bn) in 2009. Product materials for consumers, which represent the bulk of this, should grow at an annualized 5% pace over the medium term on growing demand for portable digital items like smartphones and tablet PCs, as well as emerging market demand. Meanwhile, though the market for LiB materials for automobiles was almost negligible in 2009, we expect this market to take off from around 2015 as demand for eco-friendly cars enters a genuine growth phase.

In this report, we examine up close the LiB material industry and long-term market trends over the coming years, and highlight the growth potential of various LiB materials.

Figure 1: LiB main materials market trend

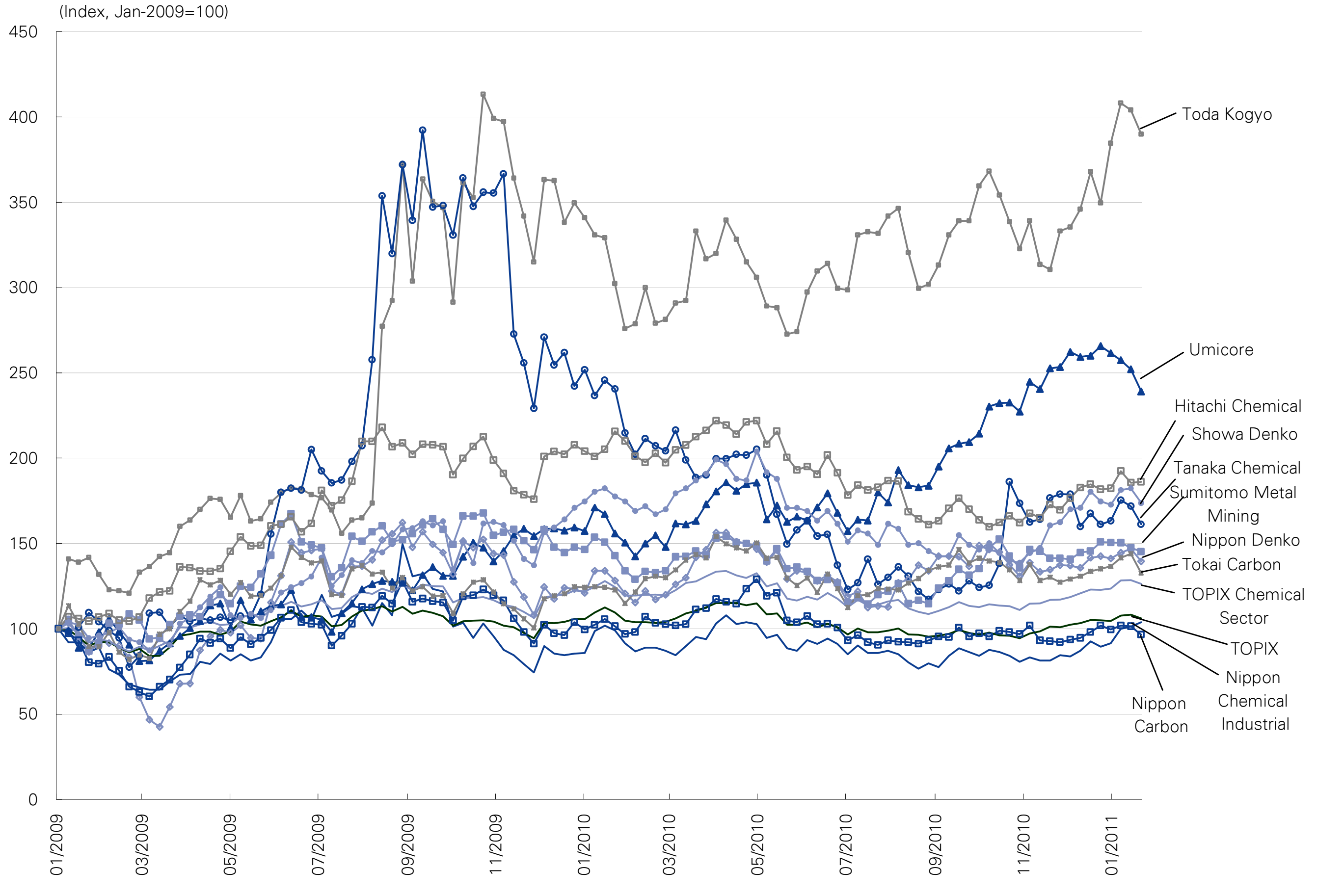


Source: Deutsche Securities estimates (from 2009 onward)

Performance of LiB-related shares

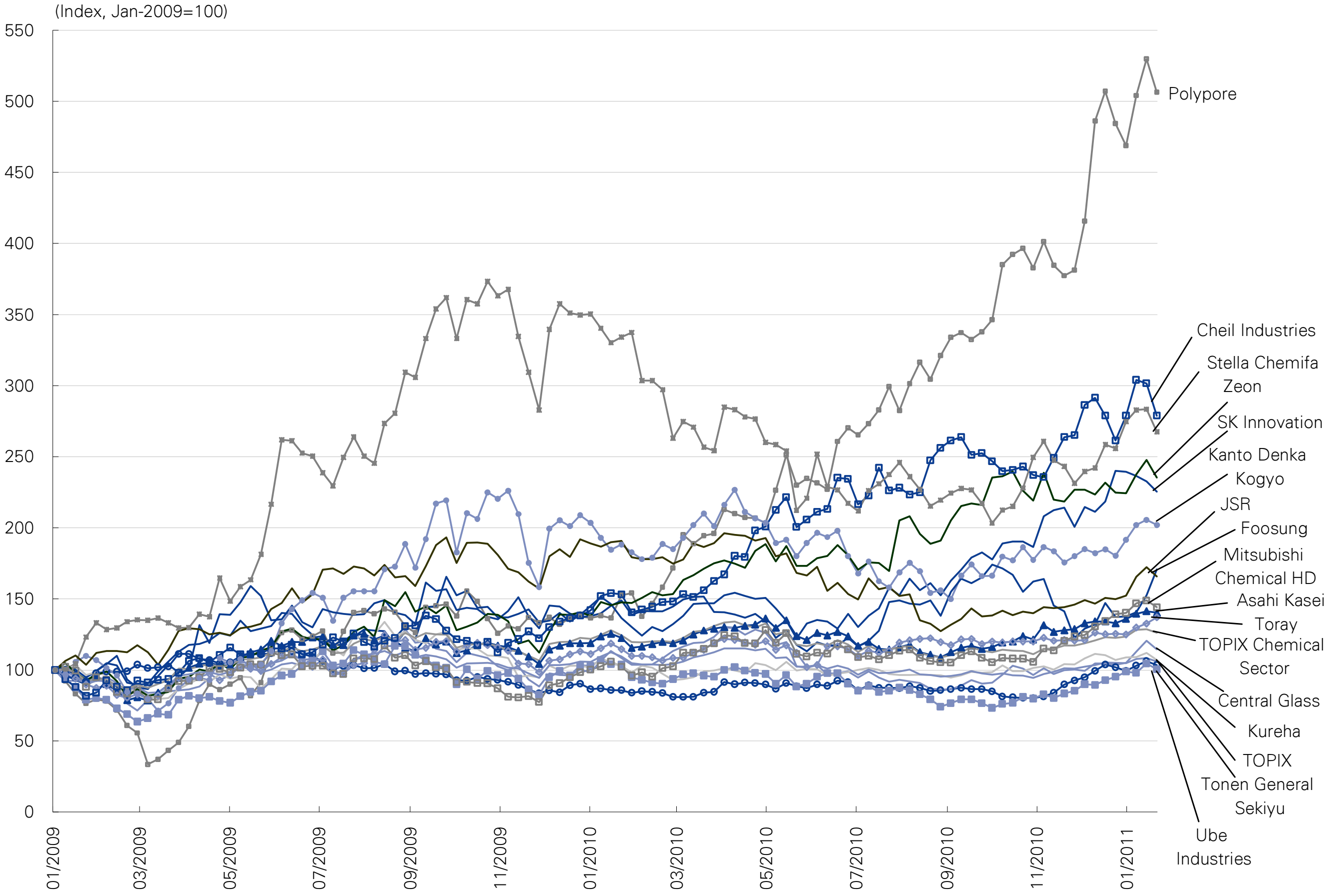
The market cap of lithium-ion battery (LiB) material makers since the financial crisis is illustrated in Figures 2 (cathode and anode materials) and 3 (separators, electrolyte solutions and binders). Overall, we expect most Japanese LiB material makers to outperform TOPIX as well as the TOPIX chemical sector. With a few exceptions, LiB materials still make little contribution to overall profits at material makers, so sweeping statements are not possible. Nonetheless, some stocks, including Toda Kogyo and Stella Chemifa, have risen considerably recently, driven by expectations of significant medium-term growth in LiB material demand for eco-friendly cars. Meanwhile, some overseas makers have also widely outperformed Japanese LiB material firms, including Umicore (cathode materials), Polypore International (separators), SK Innovation (separators), and Cheil Industries (electrolyte solutions, sold electrolyte solutions business in 2H 2010). We foresee increased news flow on eco-cars and new LiB uses in 2011, which should be positive for LiB material firms as a whole. New players continue to enter the industry, making it even more necessary to scrutinize the medium-term earnings outlook for each company.

Figure 2: Market cap trends for cathode and anode active materials related companies



Sources: Bloomberg Finance LP, Deutsche Securities

Figure 3: Market cap trends for separator, electrolyte solution, electrolyte and binder related companies



Sources: Bloomberg Finance LP, Deutsche Securities

Figure 4: Valuations for LiB related companies

Company	Ticker	Rec.	Cur.	TP	Price	Stock Performance (%)				PER (x)			PBR (x)			EV/EBITDA (x)			Mkt Cap	ROE(%)	Lead Analyst
					(25-Jan)	1m	3m	6m	1y	FY09A	FY10E	FY11E	FY09A	FY10E	FY11E	FY09A	FY10E	FY11E	(US$ m)	FY09A	
Japan-LiB																					
Sanyo Electric	6764.T	Sell	JPY	100	132	2.3	-2.2	17.9	-15.9	-16.6	96.4	39.8	7.7	8.0	7.3	10.7	9.0	8.2	9,866	-	Yasuo Nakane
Sony	6758.T	Hold	JPY	3,100	2,919	-1.4	6.5	16.2	-2.7	-71.8	40.8	23.0	1.0	1.0	0.9	6.0	4.1	3.4	35,593	-1.38	Yasuo Nakane
Panasonic	6752.T	Buy	JPY	1,500	1,160	1.4	-3.5	2.6	-20.3	-23.2	21.7	13.7	0.9	0.8	0.8	6.1	5.0	4.7	34,537	-3.71	Yasuo Nakane
GS Yuasa	6674.T	NR	JPY	—	587	3.2	1.2	7.1	-2.2	36.0	26.9	21.3	2.4	2.3	2.1	13.2	9.5	8.6	2,947	7.99	No coverage
NEC	6701.T	Hold	JPY	250	246	-0.4	7.0	4.7	0.4	48.8	43.6	18.7	0.9	0.8	0.8	4.9	5.1	4.6	7,777	1.60	Takeo Miyamoto
Hitachi	6501.T	Buy	JPY	530	453	11.0	28.3	32.4	50.3	-15.5	10.2	10.1	1.4	1.4	1.3	5.0	4.2	3.8	24,842	-9.16	Takeo Miyamoto
Toshiba	6502.T	Buy	JPY	600	493	11.8	21.7	9.6	-0.2	-100.0	25.3	12.2	2.7	2.4	2.0	7.3	5.3	4.9	25,357	-3.17	Takeo Miyamoto
South Korea-LiB																					
Samsung SDI	006400.KS	Buy	KRW	230,000	164,000	0.9	6.5	-7.6	20.6	32.4	19.2	16.2	1.4	1.4	1.3	14.6	9.9	9.7	6,660	4.59	Sc Bae
LG Chem	051910.KS	Buy	KRW	450,000	403,000	5.6	13.5	25.5	92.4	20.3	12.2	11.6	4.9	3.4	2.7	11.4	8.0	7.0	23,806	28.76	Peter Lee
China-LiB																					
BYD	1211.HK	Sell	HKD	39.3	39.05	-6.1	-23.5	-25.0	-27.2	22.1	25.4	20.3	4.8	4.6	3.9	13.6	15.1	11.7	11,403	27.13	Vincent Ha
China BAK Battery	CBAK.OQ	NR	USD	—	1.84	-6.1	-5.6	16.5	-29.5	-3.5	-18.4	36.8	0.8	-	-	-117.8	-	-	117	-21.35	No coverage
US-LiB																					
Johnson Controls	JCI.N	Hold	USD	44.0	38.61	0.7	11.1	32.6	26.9	17.4	19.4	14.9	2.5	2.6	2.3	12.2	9.6	7.7	26,038	15.55	Rod Lache
A123 Systems	AONE.OQ	Buy	USD	17.0	9.44	-1.4	-2.8	0.2	-45.8	-3.7	-6.8	-9.6	2.3	2.4	3.3	-7.7	-6.6	-9.2	989	-26.70	Dan Galves
Ener1	HEV.OQ	Buy	USD	5.5	3.98	-1.2	0.5	23.2	-11.6	-9.0	-10.5	-23.4	3.6	3.4	4.1	-16.0	-14.4	-36.8	647	-46.56	Dan Galves
Cathode material																					
Umicore	UMI.BR	Buy	EUR	46.0	35.19	-11.0	-0.2	31.5	51.4	53.3	16.0	14.5	2.7	2.7	2.4	18.9	9.9	8.7	5,761	5.67	Martin Dunwoodie
Toda Kogyo	4100.T	NR	JPY	—	897	16.6	20.2	21.7	44.4	41.9	37.2	22.6	1.9	-	-	27.0	-	-	527	4.62	No coverage
Tanaka Chemical	4080.OS	NR	JPY	—	1,342	0.8	-8.5	22.1	-31.6	50.2	48.4	44.7	2.4	-	-	8.1	-	-	206	5.11	No coverage
Nippon Denko	5563.T	NR	JPY	—	644	-0.9	4.9	21.1	13.8	412.8	12.8	10.9	1.5	1.4	1.3	23.1	5.8	5.1	863	0.38	No coverage
Nippon Chemical Industrial	4092.T	NR	JPY	—	246	21.2	30.9	23.0	14.4	-23.7	39.4	21.7	0.7	-	-	8.8	-	-	266	-2.77	No coverage
Sumitomo Metal Mining	5713.T	Buy	JPY	2,200	1,402	-1.3	6.2	22.3	9.1	14.6	11.0	7.9	1.3	1.2	1.1	9.1	6.9	5.8	9,897	9.89	Katsuhiko Ishibashi
Anode material																					
Hitachi Chemical	4217.T	Buy	JPY	2,100	1,777	6.0	15.5	4.0	-7.6	15.7	14.0	12.5	1.3	1.3	1.2	5.2	4.6	4.1	4,494	9.06	Takato Watabe
Nippon Carbon	5302.T	Hold	JPY	270	255	-5.6	-0.4	3.7	-3.8	13.6	18.3	11.7	1.0	1.0	0.9	6.0	5.9	4.8	366	7.84	Katsuhiko Ishibashi
Showa Denko	4004.T	NR	JPY	—	187	1.1	25.5	16.1	2.2	-6.4	19.9	13.0	1.2	1.1	1.1	12.2	6.6	5.7	3,398	-15.67	No coverage
Tokai Carbon	5301.T	Buy	JPY	630	498	-0.4	2.3	6.4	15.3	40.6	16.2	10.2	1.1	1.0	0.9	8.4	5.9	4.9	1,360	2.59	Katsuhiko Ishibashi
Separator																					
Asahi Kasei	3407.T	Buy	JPY	630	571	10.2	19.2	25.8	23.6	31.6	12.5	10.9	1.2	1.2	1.1	6.7	4.6	4.3	9,721	4.09	Takato Watabe
Polypore	PPO.N	NR	USD	—	44.87	6.7	29.7	72.4	226.8	-17.0	36.3	28.5	5.8	5.7	4.8	18.3	15.0	13.3	1,999	-34.65	No coverage
Tonen General Sekiyu	5012.T	NR	JPY	—	944	3.5	31.7	19.9	25.0	-24.5	12.5	9.2	2.2	2.2	1.9	-186.8	9.0	8.3	6,476	-8.72	No coverage
Toray	3402.T	Buy	JPY	620	549	12.7	17.3	22.0	8.5	-54.2	20.1	16.0	1.6	1.5	1.4	12.7	8.6	7.9	10,871	-3.01	Takato Watabe
SK Innovation	096770.KS	Buy	KRW	196,000	187,500	-3.6	17.6	45.9	73.6	25.6	12.2	11.6	2.2	1.6	1.4	15.1	8.6	7.1	15,454	9.00	Peter Lee
Electrolyte																					
Ube Industries	4208.T	NR	JPY	—	259	10.2	26.3	22.2	7.5	31.7	14.3	13.0	1.5	1.4	1.3	8.3	6.9	6.5	3,172	4.68	No coverage
Mitsubishi Chemical HD	4188.T	Buy	JPY	800	591	8.0	40.0	32.8	51.9	63.4	9.9	8.8	1.2	1.1	1.0	10.9	5.6	5.4	10,805	1.91	Takato Watabe
Cheil Industries	001300.KS	NR	KRW	—	113,000	8.7	16.9	25.6	92.5	42.6	16.1	14.6	2.7	-	-	15.4	9.8	8.4	5,036	7.10	No coverage
Electrolyte material																					
Kanto Denka Kogyo	4047.T	NR	JPY	—	724	17.7	14.2	31.6	15.7	50.3	21.9	16.4	2.3	2.1	1.9	8.2	6.3	7.7	506	4.80	No coverage
Stella Chemifa	4109.T	NR	JPY	—	3,895	9.6	14.6	13.6	-15.9	20.9	25.2	21.4	2.7	2.6	2.3	11.0	10.6	9.6	581	14.10	No coverage
Foosung	093370.KS	NR	KRW	—	4,545	20.4	4.7	13.1	18.7	52.5	-	-	3.7	-	-	31.0	-	-	343	8.10	No coverage
Central Glass	4044.T	Hold	JPY	420	416	11.5	17.8	23.1	9.8	189.1	21.0	18.0	0.8	0.8	0.8	6.9	7.0	5.9	1,085	0.42	Katsuhiko Ishibashi
Binder																					
Kureha	4023.T	NR	JPY	—	493	2.5	9.3	12.3	8.4	56.2	29.9	21.3	0.9	0.9	0.8	7.8	7.6	5.7	1,087	1.64	No coverage
Zeon	4205.T	Hold	JPY	850	757	11.2	11.5	42.6	77.2	35.6	10.9	10.3	1.6	1.5	1.3	8.6	4.8	4.7	2,224	5.00	Takato Watabe

Note: PER and PBR valuation basically based on DB forecasts for DB coverages and Bloomberg consensus median forecasts for non-coverages.

Some companies have no consensus-data. FY10 means FY3/11 for most Japanese companies and CY10 for non-Japanese companies basically. But, Nippon Carbon uses CY base. FY10 for Johnson Controls means FY9/10.

Sources: Bloomberg Finance LP, Company data, Deutsche Bank Group and Deutsche Securities

Battery types and LiB features

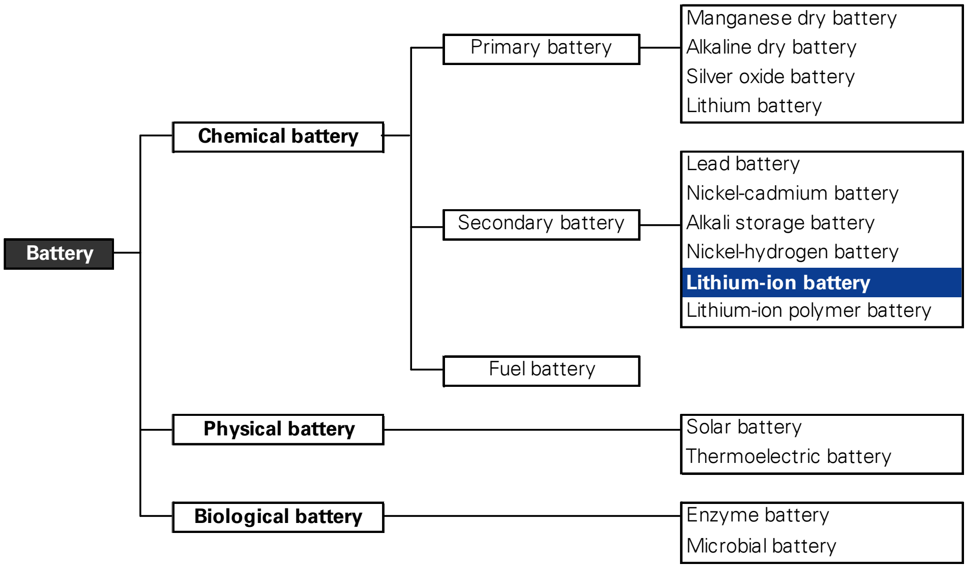
Brief overview of batteries

Three broad battery types

There are three battery categories: chemical, physical and bio. Chemical batteries generate electricity through a chemical reaction inside the battery. This category can be divided further into primary, rechargeable and fuel cell. Primary batteries are the generic name for non-rechargeable, single-use batteries. The two best known types are manganese, which utilize cheap and abundant manganese oxide, and alkaline, which use similar materials and have a similar structure to manganese cells but twice the service life. Rechargeable (or secondary) batteries are the generic name for reusable, rechargeable batteries. These are generally lead storage batteries for motor vehicles, rechargeable nickel hydride AA and AAA batteries, HEV nickel hydride batteries, and lithium-ion batteries (LiB) for small consumer goods. Fuel cell batteries for practical use are still in development. These work by drawing electrical energy from an electrochemical reaction between hydrogen and oxygen.

Electricity is produced in chemical batteries through a chemical reaction (type of energy storage device), and in physical batteries through use of physical changes in heat and light energy. Solar cells convert light energy into electricity through the photoelectric effect, which is the emission of electrons from matter after the absorption of light energy. Heat cells operate on the principle that differences in heat within matter are converted into electrical voltage. Bio batteries generate electricity through the organic activity of enzymes and microorganisms. For example, microbial fuel cells (MFC) obtain electricity by converting biochemical energy generated from the oxidization of sugar by microorganisms.

Figure 5: Type of battery



Sources: Battery Association of Japan, Deutsche Securities

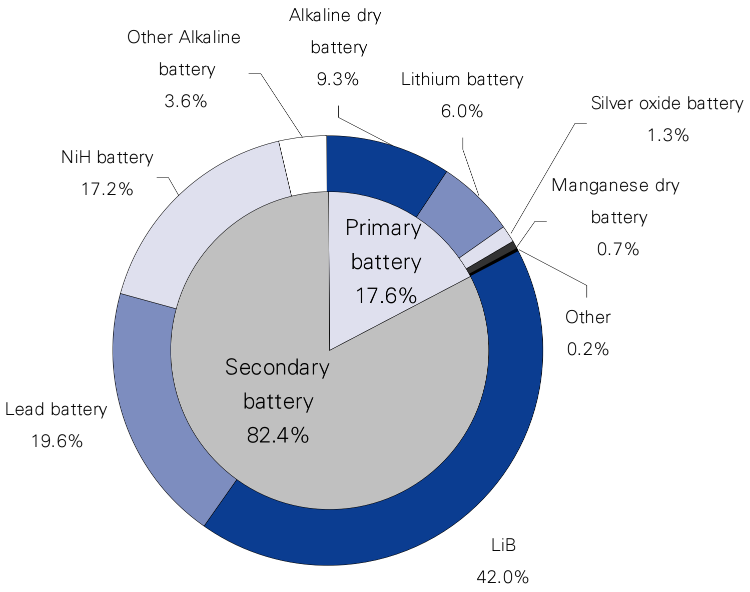
The market for different batteries

Lithium-ion rechargeable cells represent over 40% of battery market

Domestic battery production came to over ¥630bn in 2009. Rechargeable batteries accounted for over 80% of this total and primary batteries less than 20%. Lithium-ion batteries (LiBs) had the highest share among chemical batteries, constituting more than half the rechargeable battery total. LiB is the de facto standard battery for consumer products at present. Among other rechargeable batteries, lead storage batteries are used mainly in motor vehicles, and nickel hydride in widely available rechargeable batteries and hybrid cars.

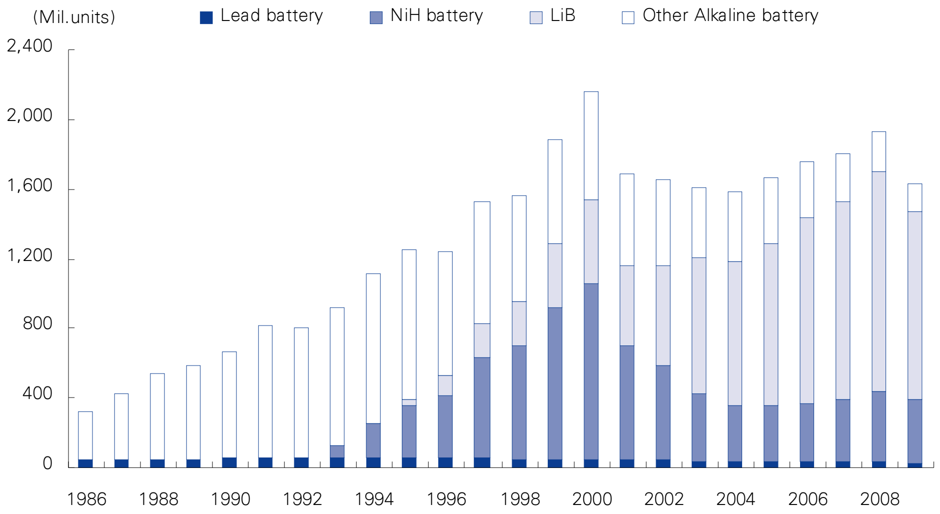
Domestic rechargeable battery sales are shown in Figure 7. Battery sales, centered on nickel hydride cells and LiBs, maintained steady growth from the early 1990s, but slumped sharply after the burst of the IT bubble in 2000. Robust demand in Asia led to a rebound until the Lehman Brothers shock. LiBs have enjoyed strong demand since the late 1990s for use in small consumer electronic products thanks to their high energy density, and in 2002 they claimed the top spot (highest shipment volume) from nickel hydride. Growth has remained robust since, with sales accounting for 67% of the domestic rechargeable battery market by 2009 (from 22% in 2000), well above nickel hydride's 22% (47%).

Figure 6: Breakdown of domestic battery production by volume (2009)



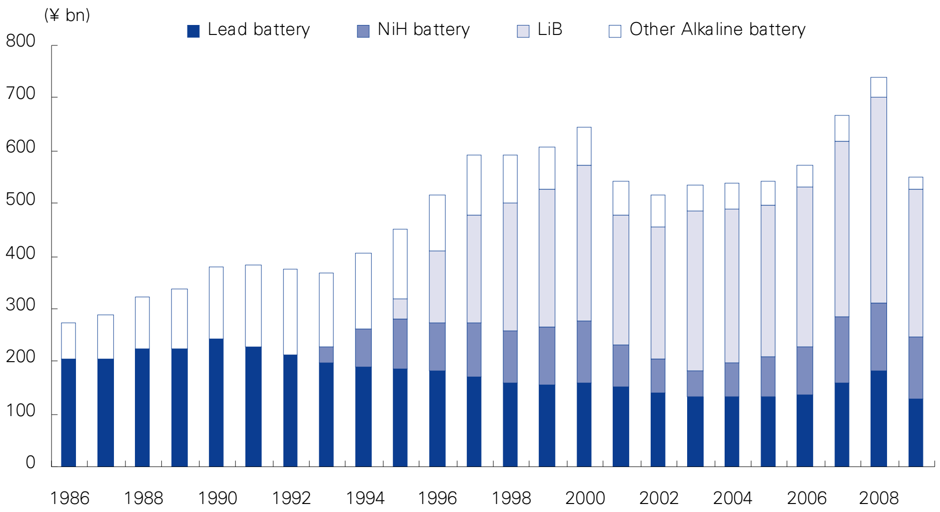
Sources: Battery Association of Japan, Deutsche Securities

Figure 7: Secondary battery sales trends, domestic (volume basis)



Sources: Battery Association of Japan, Deutsche Securities

Figure 8: Secondary battery sales trends, domestic (value basis)



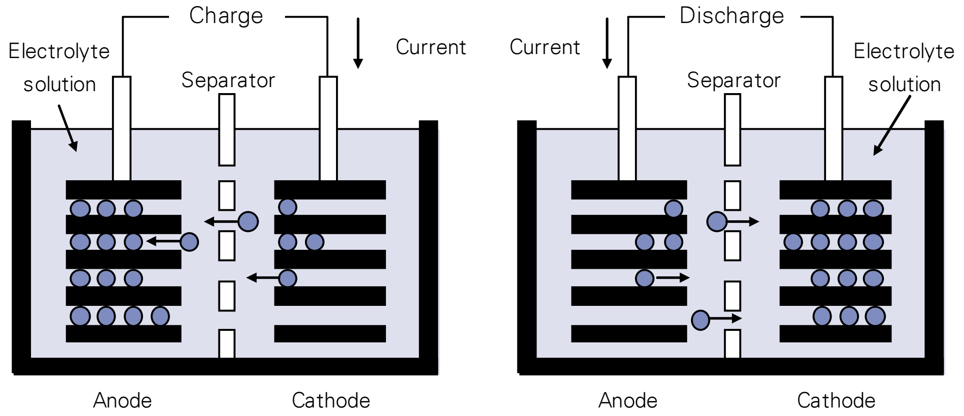
Sources: Battery Association of Japan, Deutsche Securities

Lithium ion rechargeable batteries

Four main LiB materials: cathode, anode, separator, electrolyte

Lithium-ion rechargeable batteries are made up of cathode active materials using metallic oxide including lithium (Li), and anode active materials using carbon materials such as graphite. The battery internally has a separator between the cathode and anode and is filled with an organic electrolyte solution. The separator prevents short-circuits that would occur from physical contact between the two electrodes, while protecting the electrolyte solution and thus preserving the battery's conductivity. In the recharging process, lithium ions are released from the cathode into the electrolyte solution, where they accumulate between the anode layers. During discharge, the ions return to the cathode. The movement of lithium ions between the cathode and anode during the discharge process creates an electric current.

Figure 9: Structure of LiB



Sources: NEDO, Deutsche Securities

Features of rechargeable Lithium ion batteries

Four main LiB materials: cathode, anode, separator, electrolyte

The first special feature of LiBs compared to other rechargeable batteries is their high voltage and thus high energy density. The nominal voltage of nickel hydride batteries is 1.2V versus 3.7V for LiB. Voltage refers to the pressure at which electrical current flows (when electricity is flowing in one direction). High voltage is beneficial for notebook PCs and cars, which require an adequate power source. Capacity indicates the volume of electricity that a battery can hold. The energy volume in a battery is the voltage *times* capacity, and is an important indicator of a battery's functionality. LiBs boast high energy density both per weight and per volume relative to other battery types (Figure 10). Simply put, a lighter and smaller LiB can generate the same amount of electricity as a heavier, larger battery of a different type. LiBs can be as much as 70% lighter and 60% smaller in volume than nickel hydride batteries.

The second characteristic is the absence of any memory effect. Discharge duration of Nickel-cadmium and nickel-hydride batteries gets shorter as they are used. For instance, if these batteries are recharged repeatedly to 70% capacity, discharge voltage will begin to fall sharply from the 70% mark even after a full recharge, with the battery eventually becoming incapable of holding a charge. The batteries essentially remember 70% as full capacity in a phenomenon known as the memory effect. This effect does not occur with LiBs, making them easy to top up after a partial recharge.

LiB is de facto standard for small consumer batteries

LiB has become the de facto standard battery recently for portable digital devices such as cell phones and notebook PCs due to their 1) superiority in boosting device mobility because of their small size and light weight; 2) lack of a memory effect; and 3) long discharge/recharge life cycle.

Battery sizes are listed in Figure 10 for reference. The top row in the size column is mostly the battery size code, which differs according to battery type. For example, 18650 is the standard size for LiBs. The bottom row indicates the diameter and length for cylindrical batteries, and the thickness, width and length of rectangular batteries.

Figure 10: Battery performance comparison (1)

Battery	Size	Weight	Capacity	Voltage	Volumetric Energy density	Gravimetric Energy density
LiB	18650 ϕ18.3mm*65mm	44g	2.4Ah	3.7V	520Wh/L	201Wh/kg
NiCd battery	D size ϕ34mm*60mm	152g	5.0Ah	1.2V	110Wh/L	39Wh/kg
NiH battery	D size ϕ34mm*60mm	178g	9.0Ah	1.2V	195Wh/L	61Wh/kg
Lead battery	182*127*202mm	9.5kg	32Ah	12V	82Wh/L	40Wh/kg
NiCd battery	AA size ϕ14mm*50mm	24g	1.1Ah	1.2V	172Wh/L	55Wh/kg
NiH battery	AA size ϕ14mm*50mm	30g	2.5Ah	1.2V	390Wh/L	100Wh/kg
Alkaline dry battery	AA size ϕ14mm*50mm	23.5g	0.73Ah	1.15V	109Wh/L	36Wh/kg
Lithium battery(Primary)	CRV3 29*14.5*52mm	39g	3Ah	3.9V	412Wh/L	231Wh/kg

Source: BAYSUN company website

Figure 11: Battery performance comparison (2)

	Lead battery	Nicad battery	NiH battery	LiB
Size	××	×	○	○
Weight	××	×	×	○
Memory effect	○	×	△	○
Large current discharge	○	○	△	×→△
Cost	○○	△	△	×
Environment adaptability	×	×	○	○

○○：Excllent ability ○：Good ability △：Normal ×：Inferiority ××： Defective

Source: BAYSUN company website

Let us consider LiB cost performance. The cost per unit of energy for an LiB (18650 type) for portable digital devices such as notebook PCs is around ¥130, lower than the ¥170 for a relatively small nickel hydride battery. A straight comparison between LiB and nickel cadmium is difficult given their different uses, but while LiBs are more costly, they have significantly higher energy density. Nickel cadmium is thus less suitable for portable products. Consequently, in terms of cost performance and space, we believe the balance at present is in LiB's favor.

Figure 12: Battery cost comparison

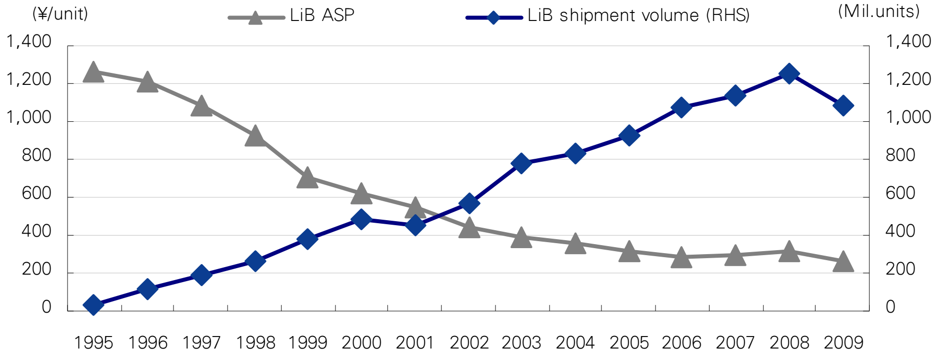
Type of battery	Application	Weight (g)	Capacity (Ah)	Average voltage (V)	Sales price (¥/unit)	Weight energy density (Wh/kg)	Cost (V/Wh)
LiB (cylindrical cell/18650)	Notebook PC, Video camera, etc	46.5	2.35	3.7	1,120	187	129
LiB (cylindrical cell/14430)	RC car, Robot, etc	17	0.6	3.7	450	131	203
Li polymer battery	Electric gun battery, etc	278	4	11.1	7,130	160	161
Li polymer battery	RC use	167	2.2	11.1	5,590	146	229
NiMH battery (size：18x67.5mm)	Notebook PC, Video camera, etc	62	4.5	1.2	900	87	167
NiMH battery (size：17x50mm)	Notebook PC, Video camera, etc	37	2.7	1.2	650	88	201
NiCd battery (C, size：25.3x49.5mm)	—	770	3	1.2	390	5	108
NiCd battery (AA, size：14.1mmx50mm)	—	25	1	1.2	220	48	183
Primary lithium battery (AA, size：14.5x50.5mm)	Radio, Smoke detector, Security gadget, etc	14.5	2.9	1.5	380	300	87
Primary lithium battery size: 26.8 x 17.8 x 49.2 mm	ERS unit, Security gadget, Alarm device, LED device, Sensor, GPS, etc	45	1.2	9	930	240	86
Primary lithium battery (disposable button cell)	Electronic device, Watch, Toy, etc	3	0.21	3	90	210	143

Source: batteryspace.jp, company data and Deutsche Securities

NEDO (New Energy and Industrial Technology Development Organization)'s "Roadmap for rechargeable battery R&D" (May 2010) notes that LiBs for electric vehicles and motors will need longer endurance to achieve full-scale diffusion. This means that higher energy density is very important. Costs must also be reduced in order to bring the cost of the vehicle in line with gasoline-powered cars. The current price is ¥100-200/Wh, but users will require a level of around ¥30 by 2015 and ¥20 by 2020. Looking at LiB sales price and shipment trends over the past 15 years, we find that prices fell by nearly half in the first five years, while shipments surged more than 15 times.

We believe that cost pressures are more intense for automotive batteries than for consumer electronics and expect a considerable reduction in the sales price in the coming five years.

Figure 13: Average sales price and shipment volume trends for LiB



Sources: Battery Association of Japan, Deutsche Securities

Applications for rechargeable lithium ion batteries

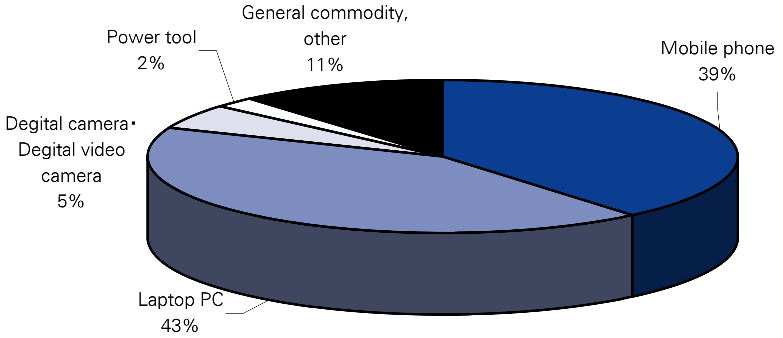
LiB's many non-automotive uses

LiBs are mostly used today for small consumer electronic products. We estimate that cell phones and notebook PCs account for around 40% each, with the remainder divided among digital cameras, power tools and other devices. We expect new applications to emerge in the coming years led by EVs as technological developments enable use of large-size LiBs.

Specific uses in mobile equipment (e.g. alternative engines, supplementary power devices) include electric-assist bicycles, electric motorcycles and EVs. Electric-assist bicycles have already come into wide use, and the number of cars and motorcycles equipped with the batteries will likely increase as well (automotive use is discussed in detail below). There are also new energy-generation storage batteries. Solar-power and wind-power generation equipment does not store energy, so it is necessary to add electrical storage devices. The storage batteries that have drawn the most attention are capacitors and electrolytic condensers, but some argue for LiB as well due to their high energy density and long life. (They are easy to attach to electricity generation systems because of their light weight and small size.) We see substantial long-term potential in these batteries for electricity storage systems.

For the same reasons, we also see good prospects for adoption of LiBs in the industrial field in construction equipment such as power tools as well as in forklifts and elevators, which presently mainly use lead batteries. Industrial equipment using long-life LiBs should be able to achieve higher capacity utilization and lower running costs. Other possible areas cover a broad range including portable medical equipment and uninterruptible power supply units for large data centers.

Figure 14: LiB application breakdown (sales volume basis)



Sources: Deutsche Securities estimates from industry data

Figure 15: Application of LiB

Field	Application
Mobile equipment	Electric vehicle Electric motorcycle Electric bicycle Electric train Boat, Craft, Vessel
General industrial machinery	Electric power tool Forklift Elevator
Portable electronic device	Notebook PC Mobile phone Digital camera, Video camera Portable audio device
Capacitor for new energies	Solar-power generation Wind-power generation
UPS (Uninterruptible power system)	Data center Communication base station Manufacturer
Medical	Mobile oxygen concentrator Mobile medical equipment

Sources: BAYSUN, METI and Deutsche Securities

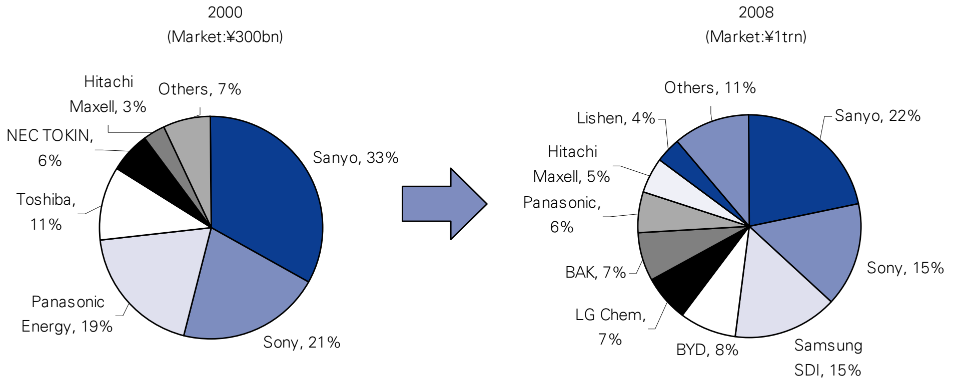
Battery and auto sector trends

Battery sector trends

Japanese LiB share shrinks in face of rising Korea and China

Japanese makers dominated the scene for some time after Sony produced and sold the first LiB in the early 1990s. However, Korean and Chinese makers have grabbed a noticeably higher share in recent years. Data from the Ministry of Economy, Trade and Industry (METI) revealed that Japanese makers controlled over 90% of the ¥300bn global LiB market in 2000. By 2008, the market had reached nearly ¥1trn, but the Japanese share had fallen well below 50%. Striking gains were made in the market by Korean makers Samsung SDI and LG Chem, and Chinese makers such as BYD. In the cell phone and notebook PC fields, which represent a large percentage of LiB usage, a higher share of production has been taken not only by Korea and China but also Taiwan. The percentage of Asian-made LiBs overall is also rising.

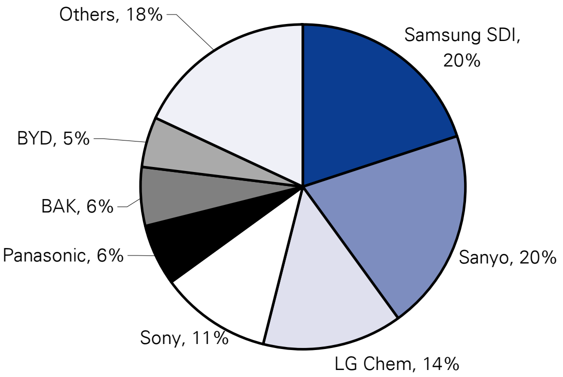
Figure 16: Global LiB market share (value basis)



Sources: METI

The *Nikkei Business Daily* (*Nikkei Sangyo Shimbun*; 17 December, 2010) reported that Samsung SDI took the top spot, if only barely, in the global LiB market in 3Q 2010 on a cell shipment basis. Korean makers including LG Chem have pursued a low-price strategy in consumer product batteries, enabling rapid shipment growth over the past half year. The article states that while earnings at Japanese makers have deteriorated badly due to a drop in battery sales prices, Korean makers appear to be doing well thanks to lower production costs from greater in-house production of LiB materials and the use of Chinese materials. We noted this trend in recent talks with material makers and were not surprised by the report. However, we do see a risk of an earnings fallout in the short term at material makers who have a high ratio of shipments to Japanese battery makers. The sustainability of the rapid ascendance of Korean makers will be an important factor in gauging the earnings outlook for material makers.

Figure 17: Global LiB market share between July and September 2010 (value basis)



Source: The Nikkei Business Daily(Dec 17,2010)

Still premature to see Korean or Chinese companies as a threat in LiB materials

Meanwhile, Korean makers Samsung SDI, LG Chem and SK Innovation are actively trying to make inroads in the car battery market. According to multiple media reports, LiBs have been designated a strategic industry by the Korean government and Korea has been aggressively increasing its capex spending. We should clarify here that this report examines trends and opportunities in the LiB material industry and is not concerned with LiB themselves or the EV industry. We believe that LiB material makers, whether their focus is on cars or electronics and whatever the relative share of battery makers that they supply, will achieve higher earnings only by distinguishing themselves through the production of high-grade materials. This was the case with electronic materials for semiconductors and LCDs. Korean and Chinese makers had previously tried to raise their in-house production of key materials for semiconductors and LCD panels, but specialized makers have retained their high profitability thanks to the high technological barriers to entry. New LiB products in the future could also have an unfavorable impact on the market share and margins of current makers, but the industry is nevertheless poised to benefit from growth in the market as a whole. As such, we do not believe that Japanese LiB material makers will face a direct threat from Korean and Chinese makers, contrary to reports by the Japanese media. Japanese makers already have sole control over certain LiB material fields.

Electric car market forecast

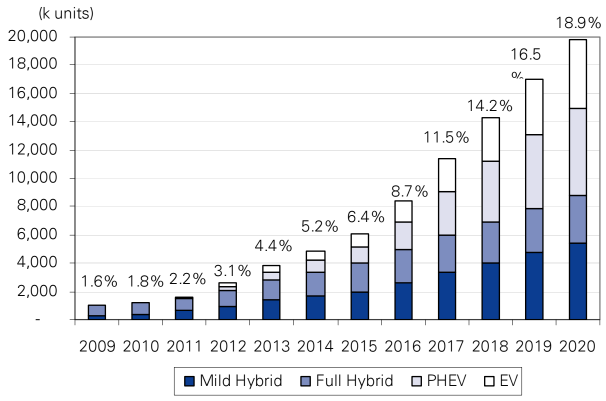
LiB materials for automotive use to enter growth phase from 2015

At present, shipments of LiB materials for automotive use are virtually zero – the majority of LiB materials are for small consumer electronic goods. We believe LiBs will be adopted in a wider variety of new fields as larger batteries are developed. However, in view of projected growth for the electric vehicle market, which is being spurred by tighter environmental regulations worldwide, we believe the highest potential lies in LiB materials for the automotive industry.

The Deutsche global automobile sector team forecasts that the global market for eco-cars (HEVs, PHEVs, EVs) will expand from 1.2m in 2010 to 6.1m in 2015 and 19.8m in 2020. Presently, hybrids (HEVs) such as the Toyota Prius and Honda Insight dominate, but we expect a shift to plug-in hybrids (PHEVs) and EVs over time. We estimate that PHEVs and EVs will account for over 10% of the world car market in 2020. Europe should be the largest market by 2020 due to its strict environmental controls, followed by the US, China, and Japan. Our forecast for the automotive LiB market, based on our car sales forecasts and our production cost projections for automotive LiB cells, is $14bn in 2015 and $57.5bn in 2020.

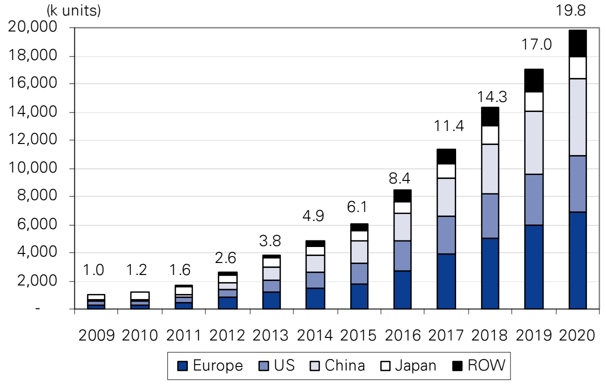
We believe one turning point for the LiB material market will come in 2015, when we expect to see to a rapid increase in LiB demand for automobiles. That is, we feel that the PHEV and EV market, which requires batteries as much as ten times larger than the standard batteries equipped in HEVs, will come into its own in 2015, marking the beginning of full-scale growth in the automotive LiB market.

Figure 18: Global xEV sales by vehicle type



Attn: %'s represent xEV volume as % of global vehicle sales.
Sources: Deutsche Bank group estimates (from 2009 onward)

Figure 19: Global xEV sales by region



Sources: Deutsche Bank group estimates (from 2009 onward)

Challenges facing LiB batteries for automotive use

Cost and power problematic for automotive LiBs

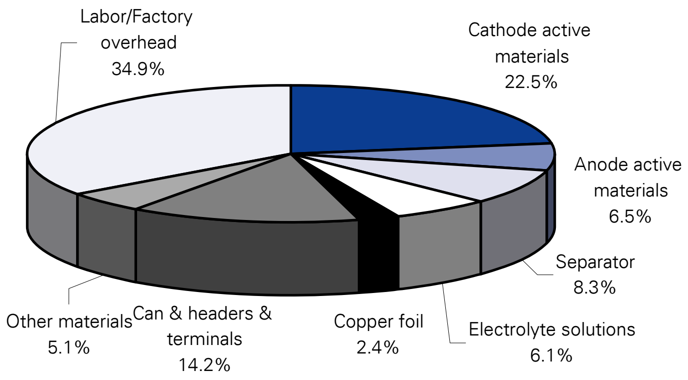
The popularization of eco-cars will require solutions to numerous problems, including battery costs and infrastructure. The biggest need is considered to be a reduction in battery costs, said to account for half of a car's price. Presently, nickel cadmium batteries are standard for HEVs, but we expect these to be replaced in PHEVs and EVs by superior LiBs. Automotive LiBs have 1.4-1.7x the energy density of nickel cadmium, allowing for smaller and lighter batteries, and this contributes to higher automobile energy efficiency. Along with the positives, however, are disadvantages. One problem with LiBs is power, specifically the need for an immediate discharge of electrical power when a car accelerates. Another challenge is high costs.

Our automobile sector research team has determined through visits to auto and auto parts makers that standard LiB packs for EVs and PHEVs cost around $650/kwh. The industry is aiming to cut this by approx. 25% to $500/kwh by 2015 through technological developments and merits of scale. It hopes to drive this down further to $325/kwh, half of present levels, by 2020.

Greater car LiB usage requires cuts in material costs

Our estimated breakdown of LiB cell manufacturing costs can be found in Figure 20. Material costs represent 65% of the whole, with a particularly high weighting for cathode materials. Cuts in production costs for LiB materials are thus crucial for bringing down car battery prices, a prerequisite for full-scale growth in the EV market. Details for each material are discussed below, but we expect cost reductions from 1) the development of alternatives for presently expensive materials, 2) an overhaul of the production process, and 3) increases in production volume. Visits to battery makers suggest that no solution is imminent in the car, battery, or material industries. We believe the simultaneous search for higher battery functionality and lower manufacturing costs will continue for several years.

Figure 20: Manufacturing costs breakdown of auto-use LiB cell



Sources: Advanced Automotive Batteries, USABC and Deutsche Bank Group estimates

Will cooperation between car and battery makers affect material makers?

Opportunity for parts makers to come out with new materials

Alliances between major car and battery makers are shown in Figure 21. The main point for LiB material makers is which group (allied battery and car makers) offers the best chance for profits. The automotive LiB field is still in its infancy, and material and specification standards have yet to be determined. There is therefore an opportunity for makers to offer their own new materials to the market. Even where affiliations already exist between non-Japanese battery makers and car makers, Japanese material manufacturers still have a chance to set the standards with their own suggested offerings. Meanwhile, supported in part by government policy, Korean battery makers will likely continue to aim for in-house production, just as they did with LCD panels. Regardless, Japanese products will be adopted if Japanese makers are able to offer differentiated products that effectively satisfy automotive needs.

We can expect various alliances among car and battery makers, but the environment is such that LiB material firms should be able to propose new material ideas to customers for some time. Thus, with certain exceptions, we do not foresee any single material maker obtaining a monopoly to supply a specific battery maker or auto maker.

Figure 21: Alliances/partnerships between automotive and LiB manufacturers

Battery manufacturers	Region	VW	Daimler	BMW	Nissan-Renault	Ford	GM	SAIC	Tata	Hyundai	Toyota	Honda	Mitsubishi
Panasonic	Japan										○ (JV:PEVE)		
Sanyo	Japan	○				○					○	○	
GS Yuasa	Japan											○ (JV:Blue Energy)	○ (JV:LEJ)
NEC	Japan				○ (JV:AESC)								
Hitachi Vehicle Energy	Japan						○						
Toshiba	Japan	○											
LG Chem	S.Korea						○			○			
Samsung SDI	S.Korea			○									
BYD	China	○											
Evonik	Germany		○ (JV:Li-Tec)										
JCI-Saft	US/France		○	○		○	○						
A123	US		○				○	○ (JV)					
Electrovaya	Canada								○				

Source: METI "Outline of the Next-Generation Vehicle Strategy 2010"

Japan and other nations are promoting their own EV industries

METI's "Next-Generation Vehicle Strategy 2010" (released April 2010) features passenger car targets for 2020-30. It wants eco-cars to account for as much as 50% of new passenger car sales by 2020 and 70% by 2030. The report says that these goals will necessitate active government incentives, such as subsidies for R&D, purchasing, tax measures and infrastructure development. METI has emphasized that the development and expansion of next-generation vehicles will not happen immediately, since: 1) there are significant personnel and time constraints when rapidly developing next-generation cars and bringing them to market, 2) gasoline-powered vehicles are likely to remain the standard in emerging nations due to their strong cost advantages; and 3) forecasts of next-generation vehicle specs vary widely, and a focus on specific technologies would carry major risk for makers. The EV industry is still in the initial phase worldwide, and we can expect cooperation between the public and private sectors in both technology and infrastructure development.

Figure 22: Vehicle shipment targets (breakdown) set by the Japanese government

		2020	2030
Existing vehicle		**50–80%**	**30–50%**
Next generation vehicle		**20–50%**	**50–70%**
	Hybrid vehicle	20–30%	30–40%
	Electric vehicle Plug-in hybrid vehicle	15–20%	20-30%
	Fuel cell vehicle	up to 1%	up to 3%
	Clean diesel vehicle	up to 5%	5-10%

Source: METI

Battery material development still in infancy

NEDO's automotive LiB development roadmap, industry data (such as Stella Chemifa's projections for new battery development) and company visits have shown that the car LiB field is in its early stages, and still not at satisfactory levels in terms of either function or price. The internal design of batteries is likely to change drastically over the long term, and new materials will be needed with every change in specifications. It is impossible to predict what kind of new materials will emerge at what time, but the survivors in the field are likely to be those that are able to provide materials suited to the times, i.e. companies with high technological prowess. Korean and Chinese firms are mounting a powerful charge in certain LiB materials, but from a long-term perspective the car battery industry is still considered to be in its infancy. Technologically strong Japanese firms, given their ability to produce new materials, are likely to be among the winners.

Figure 23: LiB R&D road map for vehicles

		2008	Improved battery (Around 2010)	Advanced battery (Around 2015)	Around 2020	Innovated battery (Around 2030)
		Small EV	Special commuter EV High performance HEV	General commuter EV PHEV	High performance PHEV	Full EV
Capability		1.0	1.0	1.5	3.0	7.0
EV	Gravimetric Energy density (Wh/kg)	100	100	150	-	700
	Power density (W/kg)	400	1,000	1,200	-	1,000
PHEV	Gravimetric Energy density (Wh/kg)	70	70	100	200	-
	Power density (W/kg)	1,900	2,000	2,000	2,500	-
EV mileage per charge (km)		80		120	200	480
Technology	Cathode	Current type (Spinel Mn, others)		High volume (Oxide solid solution, others)	High voltage (Fluoride olivine, others)	
	Anode	Current type (Carbon, others)		High volume (Carbon type)	High voltage (Li composite metal)	
	Electrolysis solution	Current type (LiPF6/Carbonate)		LiPF6 / Electric strength, Flame-resistant solvent	High electric strength (Ionic liquid)	

Source: Stella Chemifa, NEDO

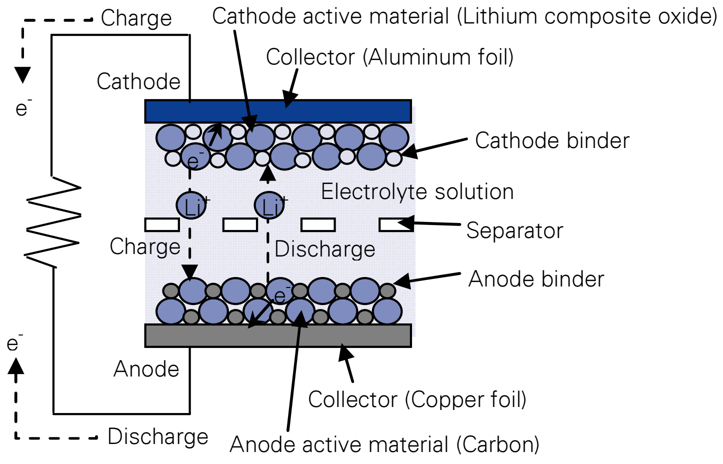
Figure 24: New battery R&D trends by main manufacturer

	Toshiba, EnerDel, Others	A123, others	Current LiB
Cathode active materials	$LiMn_2O_4$, others	$LiFePo_4$	$LiMn_2O_4$, others
Anode active materials	$Li_4Ti_5O_{12}$	Carbon type	Carbon type
Electrolyte	$LiBF_4$	$LiPF_6$	$LiPF_6$
Solvent	Lactone type	Carbonate type	Carbonate type
Voltage	2.4V	3~3.5V	3.7V

Source: Stella Chemifa

Below we look in more detail at the trends behind cathode materials, anode materials, separators, electrolyte solutions (electrolytes), and binders.

Figure 25: Schematic illustration of inside of LiB



Source: Hitachi Chemical company materials, Deutsche Securities

Cathode materials

Current market trends: Mounting competition may dent profits

Cathode material attracts most new participants

Cathode materials use lithium transition metal oxides, compounds where lithium and transition metals act as positive ions while oxide ions act as negative ions. The five principal cathode materials at present are lithium cobalt oxide, lithium nickel oxide, lithium manganese oxide, lithium iron phosphate, and a ternary compound combining cobalt, nickel, and manganese. Cathode powders are mixed with resins and a solvent medium and coated with aluminum foil to produce cathodes. Cathode materials determine battery quality (e.g. capacity, electrical output) and are therefore the most important materials in battery production. Furthermore, since they also account for the greatest part of LiB production costs, as batteries become larger so does the need to reduce cost, and this has prompted an increase in trade inquiries for high-performance cathodes enabling abundant storage space and using cheap base metals such as iron or manganese.

While market share estimates are difficult due to the large number of makers compared to other LiB components, we estimate the global cathode material market at ¥170-190bn. Talks with industry personnel and company data suggest that Nichia, Umicore (Belgium), and Toda Kogyo have relatively high shares. Consumer goods are currently the main product in which LiB are used, but we believe automotive LiBs will soon enter a full-scale growth phase, forming a nearly ¥120bn market in 2015 and ¥490bn in 2020 for cathode materials. There are more than a dozen cathode material makers, mainly in Japan and China, and competition in the consumer product market appears fierce. Consequently, we believe this will be the most difficult of the four main materials for companies to sell for a profit.

Figure 26: Cathode materials production expansion plans by main manufacturer

Manufacturer	Cobalt $LiCoO_2$	Nickel $LiNiO_2$	Manganese $LiMn_2O_4$	NCM $LiNiCoMnO_2$	Iron phosphate $LiFePO_4$	Production capacity
Nichia Chemical	○		○	○		Nondisclosure. No definite plan.
Umicore	○		○	○		Facilities in Korea and China, but no capacity disclosure. New factilies of NCM type in Kobe expected in 2011.
Toda Kogyo	○	○	○	○		Currently operate 2,500ton/year. Domestic expansion of 5,000ton/year expected by 2012. New 4,000ton/year operation in U.S expected by end-2013.
Tanaka Chemical	○			○		Currently operate 6,000ton/year. New 5,000ton/year operation expected in March 2011.
AGC Seimi Chemical	○	○		○		Nondisclosure. No definite plan.
Nippon Chemical Industrial	○			○		Nondisclosure. No definite plan.
Nihon Kagaku Sangyo		○				Nondisclosure. No definite plan.
Nippon Denko			○			Currently operate 2,700ton/year. New 4,000ton/year operation expected in February 2011.
Sumitomo Metal Mining	○	○		○		Nondisclosure. No definite plan.
Mitsubishi Chemical HD	○			○		Currently operate 2,200ton/year. Expansion to 15,000ton/year expected by 2015.
Mitsui Engineering & Shipbuilding					○	Expansion of 500-1,000ton/year in 2010. Possible expansion to 5,000ton/year.
Sumitomo Osaka Cement					○	Currently operate 150ton/year. Expansion to 1,000-2,000ton/year expected in 2011.

Source: Company data, interviews and Deutsche Securities

Major Korean battery makers have been reducing their orders to Japanese cathode material makers recently in reaction to the high yen, and are increasing their procurement from Chinese firms. However, we suspect that most of the Chinese product is low-grade material and that Japanese still reign in the area of high-performance products. Chinese battery makers also appear to be raising the ratio of cathode materials procured domestically. Japanese makers previously dominated the consumer product market, but their competitiveness weakened with the advent of Chinese rivals and the strong yen. We believe the tide in the cathode material market turned from mid-2010. For cathode materials for automobile batteries, though Chinese companies are competitive with lithium iron phosphate, Japanese companies remain superior in all other types and stand at little risk of encroachment from others in these fields.

Features by type: Consumer products buoy ternary batteries, EVs lift manganese batteries

Strengths and weaknesses of five cathode materials

There have been great strides in R&D of new cathode materials over the past several years, which has led to commercial production and wider sales. Also, following stronger efforts on the part of battery makers to cut costs, they have become more selective in buying cathode materials. Each material type has thus attracted demand for different uses. For example, high-end PCs tend to use cathodes with lithium cobalt oxide since this expensive cobalt is suitable for devices requiring a large capacity. In contrast, more cost-competitive ternary compounds are winning a higher share in lower-end products such as netbooks. Lithium manganese oxide and lithium iron phosphate are already being used in automotive LiBs. At present, it difficult to identify which type of cathode material will eventually be selected for LiBs for use in automobiles. Even though manganese or lithium iron phosphate are presently the leading candidates, we think there is a high probability that ternary compounds could also be adopted. Details on each cathode material type are as follows.

Figure 27: Relative comparison of cathode materials

	Manganese $LiMn_2O_2$	Nickel $Li(NiCoAl)O_2$ (NCA)	Ternary compounds (NCM) $LiNiCoMnO_2$	Iron phosphate $LiFePO_4$	Cobalt $LiCoO_2$
Cost	◎	○	○	◎	△
Safety	◎	△	○	◎	△
Durability	△	○	○	○	○
Low-temperature properties	○	◎	○	△	○
Actual capacity	△	◎	○	△	◎
Discharge & Charge	○	◎	◎	△	△
Thermal stability	◎	△	◎	◎	○

◎ Excellent ability
○ Good ability
△ Inferiority

Source: Yano Research Institute, Deutsche Securities

1. Lithium manganese oxide

This material suffers from low capacity and poor charge-discharge cycle characteristics in high temperatures, but boasts high output and heat resistance, giving it a strong product-safety advantage. Additionally, manganese is an abundantly available substance unlike high-priced cobalt and nickel, and thus offers superior cost performance. It is used widely for applications such as for power tools requiring high output and heat resistance. It also satisfies requirements for automotive use in terms of output, heat resistance, and cost competitiveness. Though its capacity is limited, it is presently better accepted than other materials for use in automobiles. Some manganese-based cathode materials are reportedly being used at present for EVs.

2. Lithium nickel oxide

This material is best for uses requiring high capacity. At the same time, overcharging can cause the battery to overheat, rendering its performance unstable and creating a threat to safe use. Nickel-based materials are being used increasingly in high-end digital mobile products due to 1) improvements in the heat stability of lithium nickel oxide because of advances in battery technology and 2) the mounting demand for cobalt alternatives in recent years as the cobalt-free movement gathers speed due to the high price of cobalt.

3. Ternary compounds (lithium nickel-cobalt-manganese oxide, NCM)

Ternary compounds have elements of nickel, cobalt, and manganese. By reducing the volume of costly cobalt in favor of nickel and manganese, this type can achieve higher capacity and heat resistance than cobalt cathodes. It also offers greater flexibility of design as the material mix can be adjusted to meet customer needs. Variations include cheaper products using a lower cobalt mix (one-third of the whole) and high-capacity products using a high nickel ratio.

4. Lithium iron phosphate

Since the main material is iron, material cost is cheaper than other types. However, as the compound contains additives, total manufacturing costs are not necessarily lower. Other advantages are the low possibility of an overcharge and superior heat stability. Disadvantages include low capacity as is the case with manganese based material. Presently, lithium iron phosphate appears to be only used in power tools but is considered a potential candidate for use in automobiles, where cost is an important factor. US battery makers such as A123 have a large number of patents related to lithium iron phosphate, and the Chinese battery major BYD is said to use iron as a main material.

5. Lithium cobalt oxide

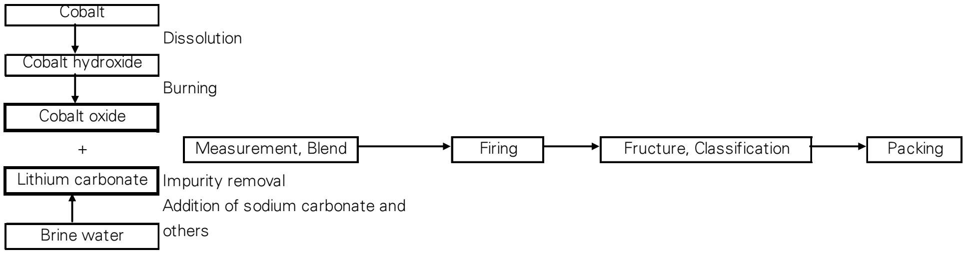
This material is the most widely used LiB cathode material thanks to its high capacity and output and superior performance. High-end mobile terminals require high performance and high capacity, qualities in which cobalt excels. However, the material is also vulnerable to market price swings for cobalt, a rare metal. As such, companies are actively working on new cobalt-free cathode materials that do not use the expensive metal but preserve the high performance it provides. The material is also inferior to other cathode materials when comparing heat stability and resistance. Makers are likely to face increasingly severe pricing pressure from battery makers as automotive LiB use expands. Therefore, we believe that cobalt-based cathode materials, long the standard for consumer electronics, will suffer a sustained decline in market share over the long term as a consequence of the growth in LiBs for cars.

Cathode material production: The firing process is crucial

Knowhow in backend firing process

A simplified production flow for cathode materials is illustrated in Figure 28. We use lithium cobalt oxide, the main cathode material, as an example. Production of cobalt oxide from cobalt and cobalt sulfate is the front-end processing. This substance is the precursor of lithium cobalt oxide. Cobalt oxide is mixed with lithium and then fired, the most important stage of the production process. Following adjustment of particle size and elimination of coarse particles, the fired item is ready for shipment to cathode makers as a commercial product. Back-end processing is carried out after mixing. Some cathode material makers like Nichia and Tanaka Chemical do both front and back-end processing, while others have only backend capabilities (using precursors procured from other cathode material makers). Moreover, a few cathode makers (battery makers) also handle their own back-end processing in house. The technological barriers to market entry are much higher for back-end than front-end processing. Producers have specialized know-how in developing and manufacturing materials to the specifications of their customers (or their own needs).

Figure 28: Manufacturing process of cathode active materials (lithium cobalt oxide)



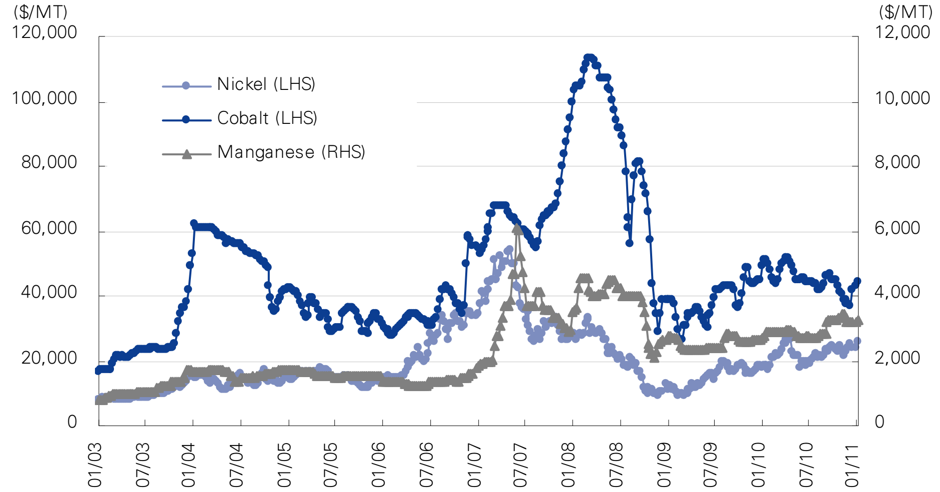
Source: Santoku, Company data and Deutsche Securities

Raw material prices: Focus on cobalt (rare metal) prices

Spot prices trending upward

Spot prices for major cathode materials are shown in Figure 29. The most expensive material is cobalt, followed by nickel and manganese. Our global commodities team forecast that nickel prices will trend upward in the coming years, exceeding $27,000/MT in 2011 and 2012 (versus nearly $14,500/MT in 2009 and $21,500/MT in 2010 which they estimate). Prices for cobalt, a rare metal, are crucial for cathode materials. We believe a sudden leap in price would accelerate the flight from the metal, i.e. manufacturers would work to reduce the use of expensive lithium cobalt oxide.

Figure 29: Main raw materials prices of LiB cathode active materials



Source: Bloomberg Finance LP, Deutsche Securities

Asian competition: Chinese lead, Koreans raise in-house ratio

Around 10 Chinese cathode material makers

There are around 10 Chinese cathode makers, shipping mainly to domestic battery makers. Visits to cathode material firms suggest that Korean battery makers are raising their procurement of Chinese anode materials, primarily low-grade materials, in order to control costs. Encouraged by the won's decline against the yen, they have been switching steadily from Japanese to Chinese cathode materials since 1H 2010. We expect market entrants from China and Japan over the next few years, and this should make cathode materials the most competitive area among major LiB materials. This could have negative repercussions on profitability.

Some Chinese cathode material makers have announced plans to aggressively hike production, and they could take a greater share of general-purpose consumer products over the long term, backed by their strong price competitiveness. In the automobile field, however, we believe Japanese makers will retain their technological dominance for some time in cathode material processing and other areas. If R&D at Chinese firms advances faster than anticipated, giving their technological capability a boost, the thereat that they will present in the future cannot be denied. Chinese firms are moving to increase their technological capacity when it comes to materials for automotive and other uses, demonstrated for example by the partnership announced between Chinese cathode material major Hunan Shanshan Advanced Material and Japan's Toda Kogyo in 1H 2010. We will monitor R&D trends and production plans at Chinese cathode material makers.

Company visits have also revealed that Korean battery makers are starting to produce cathode material intermediates as part of their efforts to strengthen in-house production. Japanese makers are already supplying cathode raw materials in some cases. As with Korean electronic material makers, a relatively large number of Korean organic chemical manufacturers have increased their in-house production. Cathode materials, though, are an inorganic chemical field requiring greater technical expertise than other chemical areas. Thus, we see little risk of significant in-house production of intermediate cathode materials. Consequently, the advent of Chinese cathode material makers and in-house cathode material production by Korean makers should impact only low-grade consumer products. High-performance areas such as automobiles should remain out of reach for now.

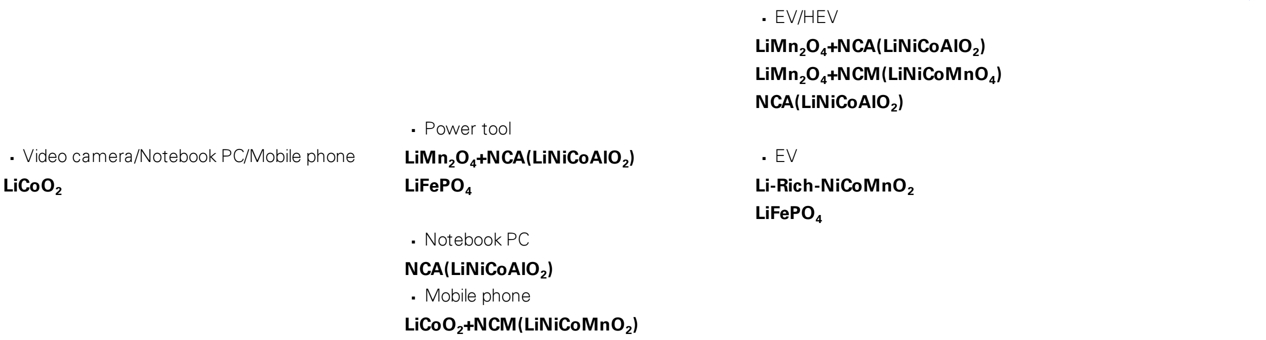
Cathode material trends

No clear leader in automotive use

Experience shows that lithium cobalt oxide, with its high energy density, has been the main cathode material for portable electronic devices requiring small, high-capacity batteries such as notebook PCs, cell phones, and video cameras. Cost-cutting pressures in final goods has intensified in recent years, spurring greater use of cheaper manganese based products, mixtures of nickel and lithium cobalt oxide, and ternary products. The exodus from cobalt was further instigated by a series of sudden fires that were caused by notebook PC batteries in the early 2000s, which were caused partly by the use of lithium cobalt oxide. In addition, since 2007, demand has shifted for cost reasons from high-priced lithium cobalt oxide to cheaper ternary and nickel types. One factor was the introduction by Korean battery makers of electronic goods using ternary materials in place of cobalt-based materials. Another was the expansion in sales of Taiwanese netbook PCs. Ternary and nickel battery sales were buoyed further by the shift in demand from expensive high-performance portable electronic devices to items offering lower but sufficient levels of portability and battery life. Meanwhile, products using motors such as power tools and power assist bicycles require batteries with high heat resistance and output. These products mainly use lithium manganese oxide and lithium iron phosphate.

These also appear to be the frontrunners for the promising automotive LiB market, though it is still not possible to say which material will become the eventual standard. Several firms are looking at ternary materials, which have good potential for the future given the balance between performance and cost. American and Chinese firms lead in iron based materials, Japanese firms in manganese based materials, and Japanese and Korean firms in ternary materials. The growth in the manganese and ternary fields is a positive development for Japanese material makers.

Figure 30: Transition of cathode active materials R&D



Sources: Toda Kogyo, Deutsche Securities

Anode materials

Current market trends: Japanese makers in strong command, led by Hitachi Chemical

Anode materials crucial to battery performance

We estimate the global anode material market at ¥29-34bn. Hitachi Chemical is the industry leader with a 45% share, while JFE Chemical, Nippon Carbon and Mitsubishi Chemical each hold 12-15% shares. That is, Japanese firms have near total control of the world market. LiB anode materials are one of the most important factors in battery performance. Japanese anode materials are used by non Japanese battery makers to a higher degree than other materials due to their high performance and quality.

Figure 31: Anode materials production expansion plans by main manufacturer

Manufacturer	Production capacity	Type of product
Hitachi Chemical	Nondisclosure. New facilities started in Ibaragi from Dec. 2010.	Mainly synthetic graphite (Partly natural graphite)
JFE Chemical	Nondisclosure. No definite expansion plan.	Mainly synthetic graphite
Nippon Carbon	Nondisclosure. No definite expansion plan.	Mainly synthetic graphite
Mitsubishi Chemical HD	Current capacity is 5,000ton/year. Expansion of 2,000ton/year by mid-2011 and target capacity to 35,000ton/year by 2015.	Mainly natural graphite (Partly synthetic graphite)
Showa Denko	Current capacity is 1,000ton/year. Capacity expansion is possible.	—
Tokai Carbon	Nondisclosure. No definite plan.	Mainly synthetic graphite
Kureha	Presently operate 600ton/year. Expansion of 1,600ton/year by January 2012. New operation in the United States in early 2013.	Carbon (Hard carbon)

Sources: Company data, interviews and Deutsche Securities

There are three broad anode material categories: graphite, carbon, and alloys. The first two are further divided into artificial and natural graphite and soft and hard carbon. Anode materials are used mainly at present for small consumer batteries, so the mainstay is artificial graphite, which is suited for high storage capacity. Graphite accounts for half of all anode materials, of which 80-90% is the artificial type.

Battery makers in recent years have been pushing hard for high capacity at low price, and there are signs of an impending shift in user demand from artificial graphite to more competitively priced natural graphite. A reduction in unit price is considered essential to spur demand for anode materials for the promising automobile field. Anode material makers will have to realize further cuts in production costs. To this end, we could see higher usage of relatively cheap natural graphite. Carbon and alloys are more expensive than graphite and have not gained wide acceptance. However, companies are eagerly pursuing R&D for automotive products, and we should be alert to potential developments.

Figure 32: Characteristics of different anode materials

Types		Characteristics
Graphite	**Natural**	As it is made from natural graphite ore, manufacturing cost is inexpensive, being about two-thirds that of artificial graphite. Moreover, as it is highly crystalline compared to artificial graphite, it has high output properties. However, it has many impurities such as metals, which gives it greater electrical resistance, and as it degrades PC solvents, it also displays problems such as inferior safety.
	Artificial	Graphite with higher purity, as impurities are artificially eliminated. Although electrical resistance is lower than in natural materials, the manufacturing cost is higher than for natural materials due to additional processes such as graphitization .
Carbon		There are two types: soft carbon, which becomes graphite when processed at a high temperature, and hard carbon, which maintains its amorphous body. At present, the issues for soft carbon are that charge-discharge behavior and cycle properties have not been sufficiently obtained. Hard carbon has high theoretical capacity and as there is little change in volume capacity, its cycle properties are excellent. However, when rapidly charging, there is a safety problem, as deposition of lithium-ion metal tends to occur.
Metal alloys		Anode material combining tin and silicon, etc. with graphite. Compared to graphite and carbon-type materials, theoretical capacity is very high. As silicon materials have a high melting point, they have excellent high-temperature properties. In contrast, tin materials have excellent cycle properties, but inferior high-temperature properties due to a low melting point.

Source: Compiled by Deutsche Securities from Japan Carbon Association, GS Yuasa, and Mitsui Mining data

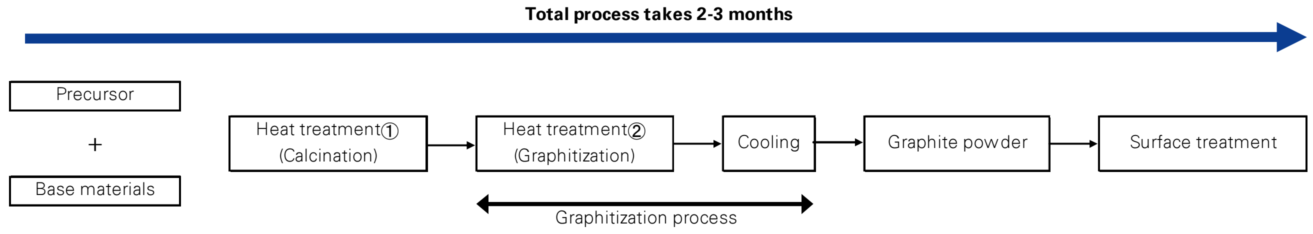
Features by type: Difference between natural and artificial graphite

Cost advantage of natural graphite

Graphite has the same prime field as a carbon atom – it is the same element but has a different (hexagonal) crystal structure. There is natural graphite as well as an artificial type produced by heating carbon to nearly 3,000 degrees to create a graphite crystal structure. Graphite is superior in heat and electrical conductivity, heat resistance, lubrication and chemical resistance. It is used in battery materials, automobile brake pads, and pencil lead.

Natural graphite is found in mines worldwide. Major producers include China, Ukraine, Brazil and Sri Lanka. Japan's imports annually around 45% of its natural graphite from China and around 15% each from Thailand, the US, and the Philippines (2009). **Artificial graphite** is derived by adding binders to oil or coal pitch coke; shaping by extrusion or dye molding; firing (heat treated at low temperatures of less than 800 degrees); then turning the whole into graphite through renewed heat treatment at around 3,000 degrees.

Figure 33: Manufacturing process of synthetic graphite for LiB anode active materials



Source: Yano Research Institute

Let us look at the differences between artificial and natural graphite. The latter includes a high ratio of impurities, burdening it with relatively high electrical resistance. It is therefore not appropriate for high-performance anodes requiring low resistance. Impurities can be eliminated from artificial graphite and the purity adjusted, so it is easy to control product quality. In terms of price, the natural version is cheaper. That is, it already exists in graphite form in nature and does not require the graphitization process, which is considered the most costly part of anode material production. Manufacturing costs are two-thirds of artificial graphite. Otherwise, the artificial version is superior in its charge-discharge cycle, while natural graphite has better output characteristics and is more suited for high storage capacity.

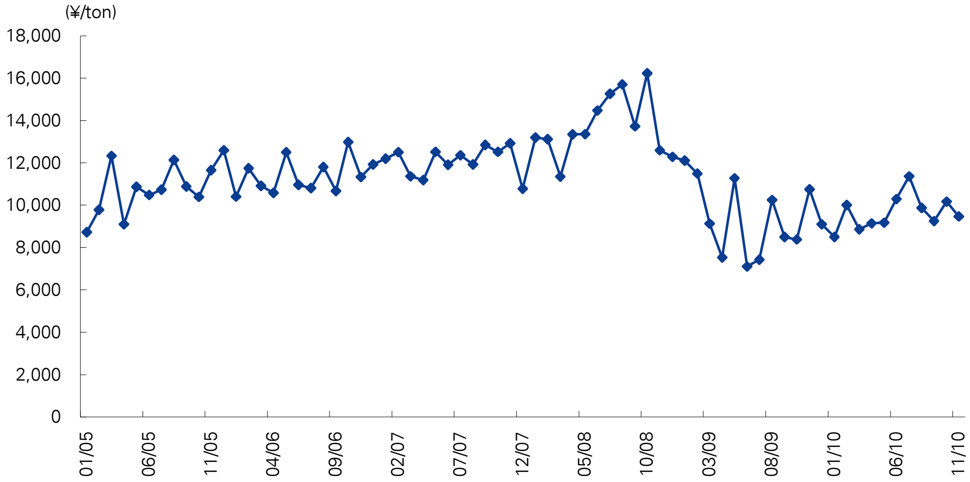
The graphitization process in artificial graphite poses a tough technical barrier to market entry, so we see little risk of oversupply in the medium term. The large capex and high running costs of the process weigh against any significant increase in new market players from an ROI standpoint. Most anode material makers do not have their own graphitization facilities and outsource the process to artificial graphite electrode makers. On the other hand, natural graphite imports come from a small number of countries, so operations depend on the strength of a firm's material procurement ability.

Raw material prices: Need more diverse sources of artificial graphite

Diversification from China as natural graphite supplier

Natural graphite prices have trended upward again since the Lehman Brothers shock. One factor is thought to be export controls imposed by China, a major supplier, in order to satisfy growing domestic demand. Japanese importers are racing to diversify their sources outside of China in order to spread their risk. We foresee possible procurement troubles ahead as LiB anode material demand enters a strong growth phase given the resource protection policies being put in place by China and other suppliers. The Japanese publication *Chemical Daily* stated in a 21 September, 2010 report that China is the source of 95% of Japan's imports of squamous graphite, an LiB material. China also levies a 20% tax on natural graphite exports. Japanese makers have established local graphite manufacturers in China, have widened their supply networks, and are likely to continue various efforts to ensure a stable graphite supply.

Figure 34 : Natural graphite import price (monthly basis)



Source: MoF, Deutsche Securities

New material trends: Hopes for high capacity alloys

Metals eventually to displace graphite

The theoretical capacity of graphite-based material is said to be nearing its limits, and hopes for a further increase are unrealistic. There is thus a growing need for new anode materials with high energy density. One material gaining attention is metallic ion (such as tin and silicon), though this has not reached the stage of commercial production. Production costs are still fairly high, but it has several dozen times the storage capacity of graphite types. Pure graphite is the main material in use now, but we believe that over the medium term there will be a shift to alloys combining metals and graphite, and then to pure metallic types. Still, there is little chance that these will be adopted for car batteries in the near term. We suspect that they will first be applied to rechargeable LiB for portable digital products.

Asian competition: Little threat at present from new Korean and Chinese rivals

Two Chinese firms are sole rivals

The only other anode material makers in Asia are the Chinese firms Shanghai Shanshan Advanced Material and China Baoan Group. There do not appear to be any manufacturers in Korea or elsewhere with meaningful supply capacity. Chinese anode makers are focused mainly on domestic battery firms, leaving Japanese firms with the bulk of the market for Japanese and Korean battery suppliers. As noted, we see little risk of cheap supply from Asian makers given the huge initial costs and high technological barriers to market entry.

Separators

Current market trends: Leader Asahi Kasei followed by US and Korean makers

Separators ensure LiB safety

Separators are placed inside a battery between the cathode and anode. They act mainly to ensure the flow of ions and prevent internal short circuiting (electrical contact between cathode and anode). A separator must have electrical insulation properties for the separator itself, but also needs good electrical conductivity to allow the flow of ions during electrical charge and discharge. Also, to prevent excessive heat buildup within the battery in case of a short circuit, separators generally have a shut-down function. They are made mainly of polyolefin and have a microporous structure. When the temperature rises, melting caused by the heat closes the pores, blocking the ion flow. The battery shuts down when the heat is excessive, and the ions cannot pass the separator. This prevents the battery from catching fire. To ensure proper operation, separators must themselves have heat resistance and electrical insulation properties. They must also have chemical stability with electrolytes and mechanical strength against thinning (leading to smaller battery sizes). At the same time, separators must have the seemingly contradictory qualities of strength and ion permeability.

We estimate the global separator market at ¥48-52bn. Asahi Kasei is the world leader with a 40% global share, followed by US maker Celgard (over 20%), Tonen Chemical/Toray (around 20%), Ube Industries and Korean maker SK Innovation.

Figure 35: Separator production expansion plans by main manufacturer

Manufacturer	Process type	Production capacity
Asahi Kasei	Wet	Currently operate 150mil.m^2/year. New 20mil.m^2/year operation expected in April 2011 and 10mil.m^2/year operation expected in June 2011.
Celgard	Dry	Nondisclosure. Expansion in South Korea in 2011. Expansion and new operation in United States in 2012.
Tonen Chemical/Toray	Wet, Dry	Nondisclosure. Expansion in South Korea by 2015.
Ube Industries	Dry	Nondisclosure. Expansion under review
SK Innovation	—	Currently operate 106mil.m^2/year. New 72mil.m^2/year operation expected in 2012.
Mitsubishi Chemical HD	Dry	Currently operate 12mil.m^2/year. It targets expansion to 72mil.m^2/year by 2015.

Source: Company data, interviews and Deutsche Securities

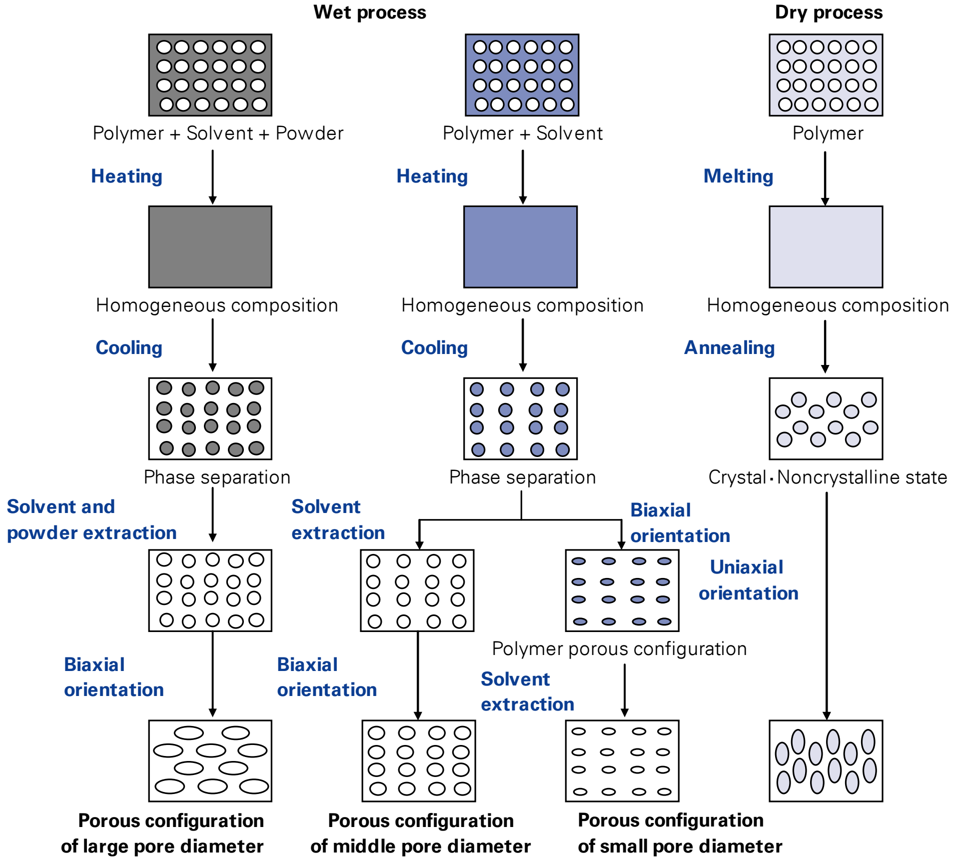
As with other battery materials, the main use is for portable digital devices such as notebook PCs and cell phones. Companies are developing separators for automotive use, and dealings with customers have already begun, including sample shipments in some cases to car battery makers. Talks with industry representatives suggest that a standard for car battery separators has not yet been established. Safety is given greater emphasis in automotive LiB materials than in consumer electronics, where separators are particularly important due to their shutdown function. A number of approaches are being tried in order to improve safety, such as a shift to thick-film products and the use of materials other than heat-resistant polyolefin. Also, research is also being done on new materials for cathodes, anodes and electrolytes, and adjustments will be necessary to ensure compatibility.

Characteristics by type: Dry process leads in automobile batteries

Wet and dry separator types

Separators require a high level of technical skill including film formation, stretching, and micropore diameter adjustment. The main material is polyolefin resin. Polyethylene is sometimes used alone and sometimes in a multilayer structure with polypropylene. Separators are divided into wet and dry processes from differences in the micropore production method. The wet method adds a plasticizing agent (additive used to soften plastics) to polyolefin resin and forms a film. The agent is then removed with a solvent and micropores are formed. The dry method involves stretching a resin, physically opening holes to create micropores.

Figure 36: Manufacturing flow of wet/dry process separators



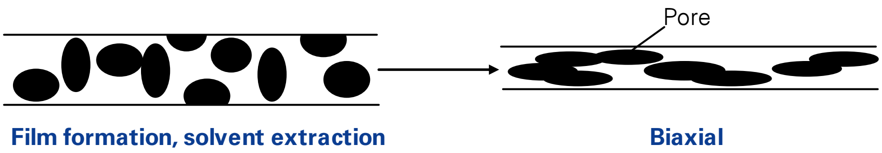
Source: Ube Industries, Deutsche Securities

The wet process uses biaxial orientation, making it resistant to shredding and stabbing and easy to adjust pore diameter. The use of a solvent in the production process also gives it good wettability against the electrolyte solution. On the other hand, the biaxial stretching causes horizontal and vertical shrinkage, and the use of solvents increases production costs.

The dry process is simpler than the wet one and thus is more cost competitive, and the absence of a solvent lessens the environmental burden. Also, since a multilayer polyethylene and polypropylene structure have become mainstay, changes in the combination of materials allow finer adjustment of the shutdown property.

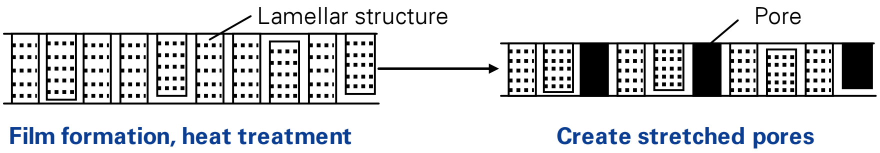
Figure 37: Dry/Wet separator process comparison

Wet pore structure



- Pore formation via solvent extraction
- Circular or fibrous structure parallel to stretching direction results in long paths for continuous pores

Dry pore structure



- Pore formation via isomerization of crystals and lamellae
- Pore diameter comparatively small, but can form pores with short paths because it is perpendicular to stretching direction, and is thus suited to automotive applications

Source: Ube Industries, Deutsche Securities

Separator demands in Japan and Korea vs China

Japanese and Korean battery makers have mainly used wet separators in consumer products because of their strength, which is necessary to endure high-speed production as these batteries are mainly produced by machine. China's battery production process is largely manual due to low labor costs, so separator strength is not as much of an issue as batteries produced by machine. Dry separators are low priced, putting them in high demand in China. In China's consumer LiB production, dry separators are the de facto standard, while Japanese and Korean LiB manufacturing equipment mainly employ wet separators. Switching between wet and dry is not easy, involving new capex. We believe that makers employing both methods will dedicate their lines for different uses, such as by devoting their existing wet separator equipment to consumer products while installing dry separators in their new plants for car batteries.

Figure 38: Comparison of dry/wet process separators

		Wet type	Dry type
Main players		Asahi Kasei, Tonen Chemical/Toray	Celgard, Ube Industries
Material types		Mainly simple PE	Mainly three layers of PP/PE/PP
Production cost		Higher cost than dry type	Lower cost than wet type
Manufacturing process		Many processes, complex	Simple and easy
Stretching		Biaxial	Uniaxial
Microporous formation		Solvent extraction and stretching	Physical micropore creation through stretching
Layer structure		Single layer is mainstream, some are multilayer	Three-layer structure is mainstream, some are single layer
Environmental load		Large, as solvent is used	Small, as solvent is not used
Characteristics	**Strength**	High-strength	Compared to wet type, weak when stretched in transverse direction
	Elasticity	Excellent	Inferior to wet type
Method of forming paths for ion transfer	**Thickness uniformity**	Superior to dry type	Inferior to wet type
	Pore size adjustment	Easier to adjust than dry type	Adjustment based on resin technology and stretching technology

Source: Partially revised by Deutsche Securities, based on "Present and Future of Lithium-ion Battery Market~Materials Edition", Yano Research Institute Ltd.

New material trends: Polyolefin (dry, wet) to remain main type for now

Polyolefin to remain mainstay for car batteries

The wet process is superior in precision processing such as thick film and pore diameter, but is more complicated and costly than the dry process. (Industry representatives indicate that the sales price for wet separators is 30% higher than for dry separators.) The dry process is generally expected to become the standard for automotive LiBs. Still, the wet process is also seen as a possibility, and it is not known at present which will come out ahead.

R&D developments and user test results suggest that polyolefin separators will remain the predominant choice for now. Research on bonded material and cellulose separators is also under way, and several companies appear to be aiming for early commercialization. The materials themselves had not been considered strong enough to withstand the micropore production process, but success has reportedly been achieved recently thanks to technological advances. We do not expect polyolefin types to lose significant market share in the short term, but we should watch new developments closely to assess the outlook for the separator sector. Also, while commercialization is still far in the future, some companies are working on solid LiBs using gels or solid electrolytes and thus not requiring separators at all. With little danger of fire, such materials would attract attention from a safety perspective.

In the end, we believe that demand for polyolefin separators will continue to grow for automotive LiBs among other uses for the foreseeable future, given the state of current technologies and progress in new technologies.

Asian competition: Focus on Korea’s SK Innovation

No threat from Chinese firms

There are only two Chinese makers in the field, both of which concentrate on supplying domestic battery makers. There has been no information pointing to any disturbance in the present supply/demand balance such as a major increase in production capacity. Korea’s SK Innovation entered the separator market in 2005 and appears to be enjoying rising sales to domestic battery manufacturers. SK Innovation will reportedly supply LiB to Mitsubishi Fuso Truck and Bus for its next-generation hybrid compact and to Hyundai for its compact EV. SK Innovation’s has annual production capacity of over 100m square meters for separators. It plans to raise this to nearly 180m by 2012 to meet projected growth in car battery demand. The Korean government announced a strategy in mid 2010 to increase the nation’s competitiveness, which included a strengthening of the LiB sector. It aims for a higher share of battery production, higher in-house parts production, and greater resource protection. Given this national push, we think it is important to monitor developments in Korea regarding LiB materials, including separators.

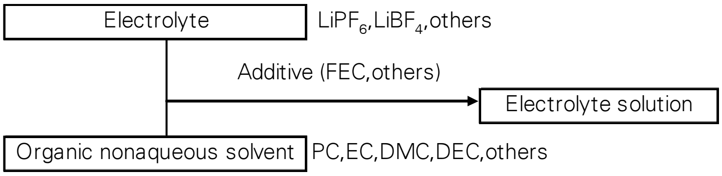
Electrolyte solutions and electrolytes

Current market trends: Tight race between Japan and Korea in consumer product electrolyte solutions

Electrolyte solution: A fluid combination of technical expertise

Electrolyte solution consists of electrolyte (lithium-ion substances that pass through separators in battery cells), organic solvents, and additives. For electrolytes, lithium borate tetrafluoride (LiBF4) and other compounds are used in some batteries, but lithium phosphate hexafluoride (LiPF6) is the most common. The main solvents include propylene carbonate (PC), ethylene carbonate (EC), dimethyl carbonate (DMC), and diethyl carbonate (DEC). To improve battery functioning, additives (such as fluoroethylene carbonate, FEC) are used, but the quantity and specific additive used vary by battery maker depending on company expertise, and no generalization is possible. Development of reliable additives is crucial for improving and stabilizing battery performance. Production of electrolyte solution is done through vendor supply of electrolytes, additives, and other materials to companies which then formulate the chemical solutions specified by battery makers, their customers.

Figure 39: Manufacturing process for electrolyte solution



Sources: Company data, interviews and Deutsche Securities

Competition in electrolyte solution production is intensifying; wide-ranging product development skills becoming more important

We estimate that the global market for electrolyte solution is valued at ¥37-40bn. Ube Industries and Panax Etec of South Korea (we understand that Panax acquired Cheil Industries' electrolyte solution business in 2010) have leading market shares of around 30% each in monetary terms. We believe Mitsubishi Chemical HD, Tomiyama Pure Chemical Industries, and other companies have high shares as well. Cathode material and anode material quantities per battery unit have increased because manufacturers are increasing cell capacity, but this has reduced the volume in which electrolyte solution can be filled. This has meant that use of electrolyte solution per battery unit has fallen. Nevertheless, we think the electrolyte solution market has ample room to grow, given prospects for accelerating growth in LiB demand.

Electrolyte solution makers buy electrolytes from outside sources, but they formulate solutions differently depending on whether they acquire solvents and additives from outside sources or produce them internally. Production processes for electrolyte solution are difficult to discern because much of the relevant information is not disclosed publicly. The solution has contact with all major components and materials (cathode and anode materials, separators), meaning that chemical affinity and compatibility are particularly important. Moreover, internal designs differ by battery maker. The required specifications for electrolyte solution vary, so broad-ranging product development skills are crucial for meeting company needs.

Figure 40: Electrolyte solutions production expansion plans by major manufacturers

Manufacturer	Production capacity
Ube Industries	Nondisclosure. Expansion plan under review
Tomiyama Pure Chemical	Nondisclosure. No definite plan.
Mitsubishi Chemical	Currently operate 8,500ton/year. Expansion to 33,500ton/year expected in 2012 and 50,000ton/year in 2015.
Panax Etec	Nondisclosure. No definite plan. Business acquisition from Cheil industries in 2010.
LG Chem	Nondisclosure. No definite plan.
Shanghai Shanshan	Capacity is 3,000ton/year as of 2009. No definite plan.

Sources: Company data, interviews and Deutsche Securities

Electrolyte: High technical hurdles to market entry; Japanese firms have commanding share

We estimate that the global market for electrolyte is ¥11-12bn. The three largest makers are Kanto Denka Kogyo (KDK), Stella Chemifa, and Morita Chemical Industries. Korean and Chinese makers lag behind them. The three major Japanese makers have a combined share of more than 90%. KDK and Stella Chemifa are currently the only makers capable of producing high-grade (high-purity) and stable electrolyte that satisfies standards for automotive applications. Hydrofluoric acid, the main raw material in electrolyte, can easily explode, so stringent controls over raw materials are essential. Also, the purification technology required and other challenges create high technical hurdles to market entry. Only a limited number of companies have the technological skills to produce fluorine, a skill necessary to make meaningful inroads in the market. This suggests that the number of market participants will not increase much. Also, the qualities required of electrolytes are basically the same for consumer and automotive applications. Consequently, companies that commercially produce electrolyte for consumer applications can more easily jump into automotive applications compared to other material makers. In sum, risks of eroding profit margins are low due to the high technological barriers in the market, and demand for electrolyte should increase as local electrolyte solution makers emerge in China.

Figure 41: Electrolytes production expansion plans by major manufacturers

Manufacturer	Production capacity
Stella Chemifa	Presently operate 1,300ton/year. New 1,300ton/year operation at Izumi facilities by end-2011.
Kanto Denka Kogyo	Presently operate 1,300ton/year. Expansion to 2,000ton/year expected in May 2011.
Morita Chemical	Presently operate 1,200ton/year. JV in China will increase capacity by 800ton/year in early 2011. Expansion to 4,400ton/year by 2012 is its target.

Source: Company data, interviews and Deutsche Securities

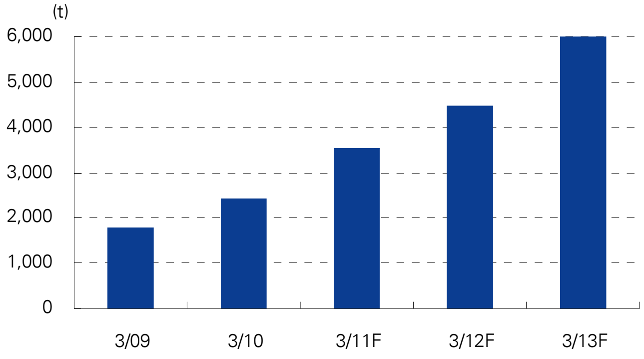
Bright prospects for the two major electrolyte producers

Forecasts for long-term electrolyte demand by the two major producers (disclosed when 1H FY3/11 results were announced) are noted here for reference. We conclude that prospects are favorable for both companies. At KDK, we think demand for electrolyte will rise steadily, backed by 1) increasing demand for all applications, including mobile phones and notebook PCs and 2) future growth in the automotive LiB market. The company looks for demand to rise from an estimated 2,400 tons in FY3/10 to 6,000 tons in FY3/13. Stella Chemifa estimates that demand for automotive electrolytes will climb from around 1,500 tons in 2015 to about 5,000 tons in 2020.

Stiffening competition in additive field

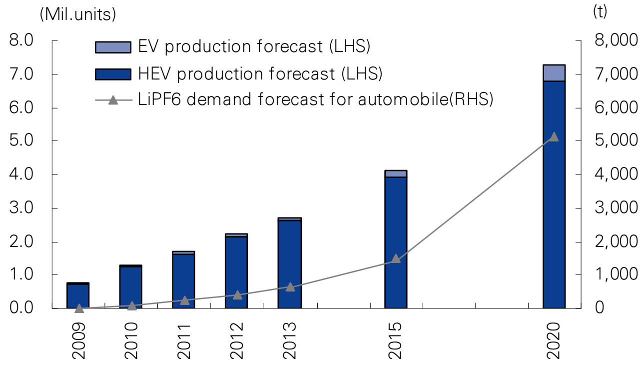
In the case of FEC, an important additive (KDK has a commanding market share) the industry is undergoing major structural changes. KDK estimates that FEC demand was nearly 200 tons in FY3/10 and believes the market will grow steadily to 700 tons in FY3/13. However, Korea's share of the global market has increased sharply in FY3/11. Chinese and Korean producers are making major inroads into the FEC market. Korean producers, in particular, have been purchasing output from Chinese companies, purifying it, and selling it to their own customers. In 2010, we think relatively brisk sales by Korean battery manufacturers also lifted sales by Korean FEC producers. We see this situation as likely to continue in FY3/11 and that Korean and Chinese producers will quickly capture share in the typical pattern seen for products with relatively low technological barriers. Also, even though significant share gains in Asia like those for FEC cannot be confirmed for other products, we see similar risks and believe the situation deserves to be monitored.

Figure 42: Electrolytes ($LiPF_6$) demand forecasts



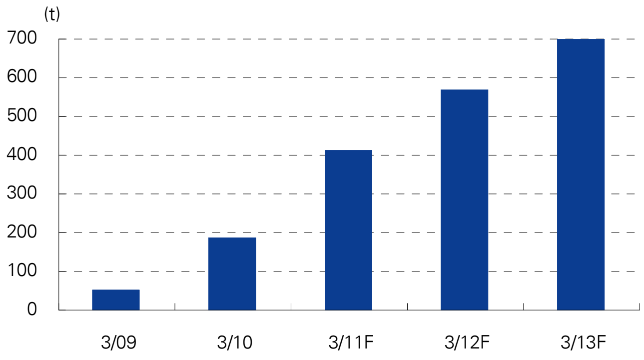
Source: Kanto Denka Kogyo estimates

Figure 43: Electrolytes ($LiPF_6$) demand forecast for automobile use



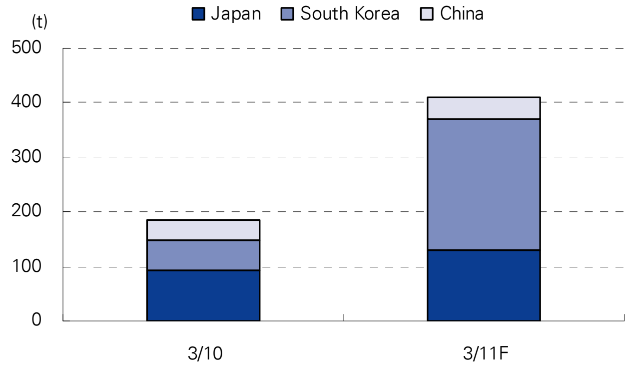
Source: Stella Chemifa estimates

Figure 44: Fluoroethylene carbonate demand forecasts



Source: Kanto Denka Kogyo estimates

Figure 45: Fluoroethylene carbonate market share by country



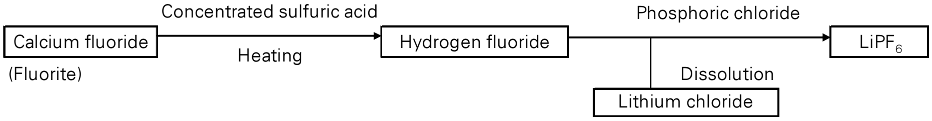
Source: Kanto Denka Kogyo estimates

Raw material prices: Fear of hike in Chinese electrolyte material export taxes

Most fluorite (a raw material for making electrolyte) is in China

Electrolyte accounts for the highest portion of the cost of producing electrolyte solution. We think price trends for electrolyte, meaning LiPF6, will have a major impact on profits from electrolyte solution. Fluoric acid (an aqueous hydrogen fluoride solution) is the main chemical in FiPF6. Hydrofluoric acid is produced by the reaction of calcium fluoride (fluorite) and sulphuric acid. China is believed to have around half of the world's fluorite reserves. The Chinese government has strengthened protectionist policies for mineral resources in recent years because of growing domestic demand. Measures include higher export tariffs and export limitations for fluorite and hydrofluoric acid. Based on our interviews with representatives of the electrolyte industry and other analysis, we think projections that prices of hydrofluoric acid will continue rising are reasonable (many observers think prices will probably rise moderately without surging in a repeat of 2008).

Figure 46: Manufacturing process for electrolytes

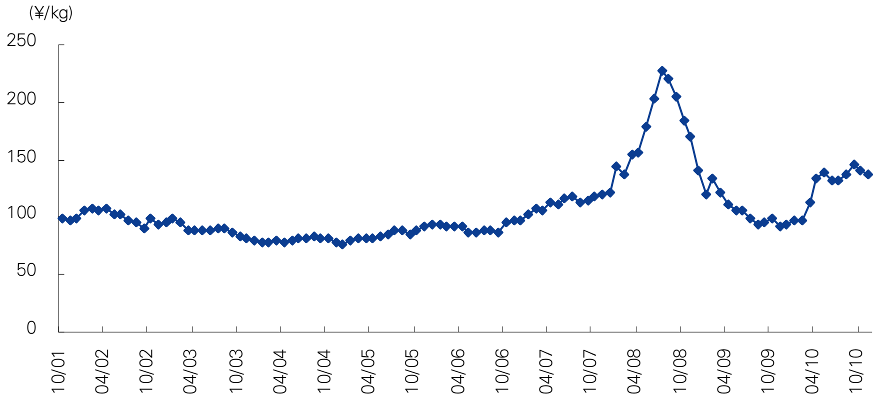


Source: Company data, Deutsche Securities

Looking for ways to secure stable hydrofluoric acid supplies

Japanese makers have been emphasizing the importance of having diverse raw-material hydrofluoric acid suppliers for some time. Previously, Stella Chemifa and Morita Chemical Industries gained legal ownership rights to mountains in China for fluorite extraction. The aim was to build integrated production systems beginning with hydrofluoric acid and to lower costs. At the time, export tariff hikes only targeted fluorite. Because tariffs have now been raised for processed hydrofluoric acid, however, producing the chemical locally in China no longer has any advantages. However, Stella Chemifa has reportedly had success in developing purification technologies using fluorite produced in Africa, and other companies are apparently working to secure stable raw-material supplies behind closed doors.

Figure 47: Hydrofluoric acid import price (monthly basis)

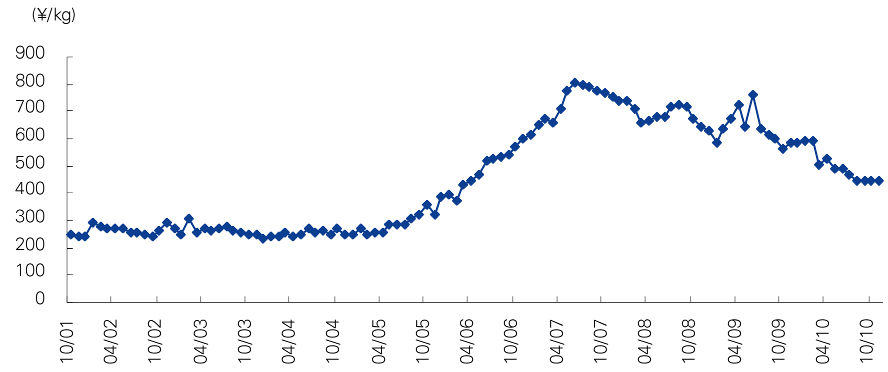


Source: MoF, Deutsche Securities

Discussion of risks of surging lithium carbonate prices would be premature

Lithium carbonate is one of the materials used for electrolyte solution, but because the volume of its use is low the influence of price changes is less than that for hydrofluoric acid. For reference we provide below data on Japanese import prices. Lithium is also used as a cathode material. According to our discussions with persons in the battery materials field, initiatives to secure lithium resources are picking up momentum, but absolute amounts necessary for battery use are still small, and there is not a sense that price hikes are imminent judging from demand and supply conditions. Until the market for electric cars grows in earnest as anticipated (starting in 2015), we see little risk that lithium supplies will tighten and lead to price increases.

Figure 48: Lithium carbonate import price (monthly basis)



Source: MoF, Deutsche Securities

Asian competition: Chinese could enter low-grade electrolyte solution market

Japan, Korean stronghold in high-performance electrolyte solution field not easy to topple

Electrolyte solution producers in Korea (two companies) and in China (about five) are now increasing shipments to domestic battery makers. Electrolyte solution for consumer applications extends broadly from low-grade to high-grade output. In China (where supply has been rising in recent years) most electrolyte solution is shipped in the low-grade and low-priced volume zone where local companies can compete effectively. Korean companies are believed to be improving quality substantially by working together with major battery makers in the home country. According to our interviews with persons in the electrolyte solution field in Japan, profit margins are being maintained to some extent, but competition is fiercer than before and profitability has been falling. In short, the electrolyte solution market has lower barriers to entry than other materials because it is produced using simple processes combining several materials. Moreover, initial investment for production is relatively small. This is attracting more new entrants into the field. We heard, however, that intensifying competition and weakening profit margins are limited to low-grade products alone. Since electrolyte solution is a material that comes into contact with all important components and materials, as noted, compatibility with them is crucial. Producing high-performance electrolyte solution that fully satisfies this need requires sophisticated engineering and know-how in material formulation and other areas. Automotive applications are expected to be a growth market. Here, since quality is paramount, Japanese and Korean makers have a technological edge over peers. For these reasons, we see little cause for concern about deteriorating profits in the high-performance electrolyte solution field. In the general-purpose commodity field, however, we think Chinese companies will increase market share.

Korea slightly upbeat, but we expect Japanese companies to retain their advantage

For electrolyte, the technological barriers to market entry are significant, as noted (obstacles include development capabilities for additives, patents, and stability and reliability requirements). We think Japanese makers can retain their competitive edge through stringent quality control of raw materials and other means. However, Chinese and Korean makers have been stepping up production. Foosung of Korea (a maker of specialty gas materials and other products) is producing electrolytes ($LiPF_6$). It mostly supplies electrolyte solution makers in Korea. Some Chinese electrolyte makers seem to be starting domestic production. Jiangsu Guotai, China's largest electrolyte solution producer, is reportedly conducting R&D on $LiPF_6$.

In conclusion, China will likely increase share at the low end of the electrolyte solution field. However, we expect Japan and Korea to retain their lead in automotive applications, and we see little reason for concern that they will quickly lose market share in the high-end area. In addition, few new producers are entering the electrolyte market, and no Chinese makers have entered the field at this point. This suggests that profitability can stay high.

Binders

Current market trends: Kureha dominates electrode PVDF, two rubber firms strong in anodes

Zeon and JSR merit attention for strengths in rubber binder field

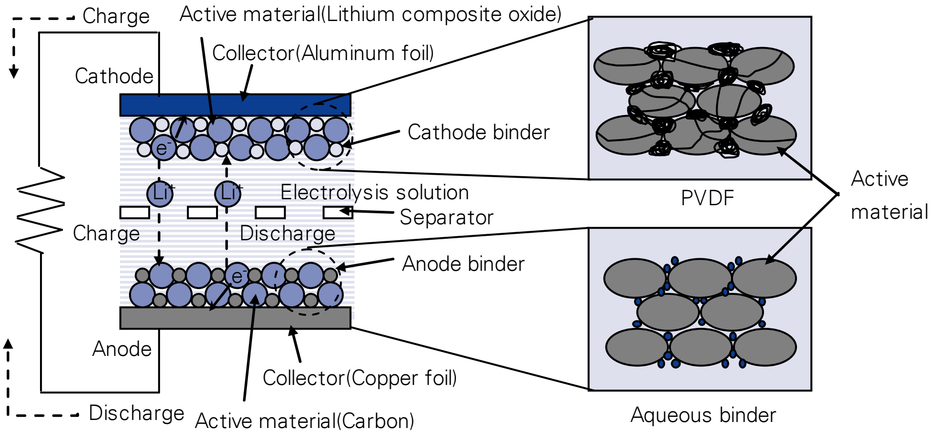
Aside from the four main LiB materials (+electrolyte) discussed earlier, other important materials include binders, current collectors, and battery cases. First, we analyze binders and their relationship to the chemical industry.

Binders have both cathode and anode active materials (materials receiving or emitting electrons) or they combine active materials with current collectors (materials that collect electricity during charge and discharge) and facilitate smooth conduction through batteries by maintaining conductivity. Because binders themselves are not conductive (being resistant components in batteries), minimizing their use is advantageous. Consequently, materials require good connectivity and flexibility.

They are two main types of binders: fluorinated and non-fluorinated binders. Polyvinylidene fluoride (PVDF) resins containing fluorine are becoming the preferred cathode binder material because they provide higher resistance to oxidation than other binders, an important requirement. PVDF resins have superior resistance to oxidation, and expansion of electrolyte solutions have also been used to make anode binders but because their bonding properties are inferior, use of non-fluorinated (aqueous) binders for anodes has been increasing in recent years. In addition to having better bonding properties, non-fluorinated binders have lower running costs, and greater environmental compatibility than PVDF. Battery properties vary considerably depending on how binders and LiB electrode materials are combined. For this reason, binder makers need to develop products combining an array of different materials, and they work to develop a broad range of products.

Demand for binders is around 1,000 tons annually. Cathode binders reportedly account for about 60% of the total. For cathode binders, Kureha (a maker of PVDF resins) has the largest market share. For anode binders, rubber binders are now most widely used. We believe that Zeon and JSR have high market shares.

Figure 49: Schematic illustration of binder



Source: Hitachi Chemical company materials, Deutsche Securities

LiB material sector trends

Automotive LiB material market trends

LiB materials industry: Expected to grow 5% annually

The market for the main LiB materials (cathode materials, anode materials, separators, and electrolyte solution) was valued at nearly $3.5bn (about ¥280bn) in 2009. Hardly any sales were for automotive applications. Most were for consumer applications. First, in main consumer applications (mobile phones, small PCs, etc.), we expect market growth to stay firm over the long term because of 1) higher sales of new types of portable digital devices, as represented by smartphones; 2) growing demand for power tools and other power-using devices and equipment; and 3) broader storage battery applications in new energy fields such as solar-optics and wind power. In 2010-2020, we forecast CAGR of about 5% for consumer applications. We estimate that the market will grow to $4.6bn in 2015 and $5.9bn in 2020.

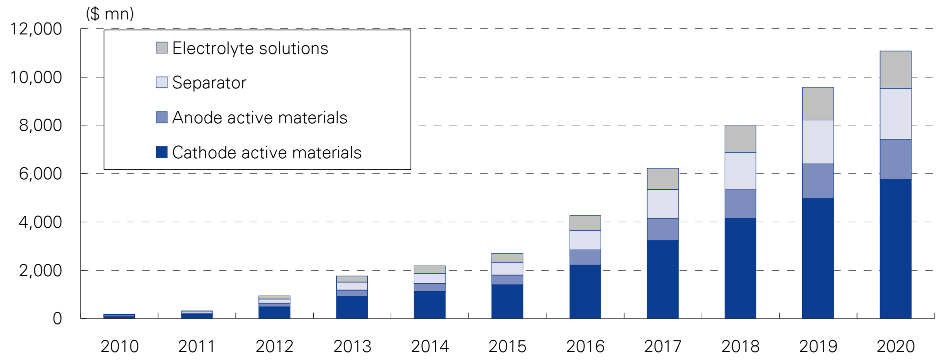
LiB materials entering high-growth phase in 2015

In automotive applications, we think the automotive LiB market will start growing in earnest in 2015. Anticipating this growth, component-materials makers are competing fiercely behind the scenes, while their customers are studying materials they want to use. For this application, quickly securing supply capacity is just as important as making advances in R&D. Eventually, much higher volumes of LiB materials will be used for cars than for consumer electronics. We understand that in general battery makers and automakers want to ensure that supply capacity is sufficient for there to be stable LiB material deliveries beginning in the sample shipment phase. Consequently, we think makers of these materials will have to install some supply capacity before their orders reach a high level. Moreover, judging from known schedules for capex by materials makers, we expect most new facility construction and capacity increases for current facilities will be made in 2011-2012. For materials makers, we think the next few years will mark a major turning point.

Automotive applications market to surpass the consumer applications market around 2016

Small shipments of LiB materials for electric vehicles (EVs) have already begun, as commercial production of Mitsubishi Motors' i-MiEV, Tesla's Roadster, and Nissan's Leaf had begun by 2010. After almost no sales to vehicle assemblers in 2009, we estimate they were $170mn (around ¥14bn) in 2010. Thus, although still extremely small, the market for LiB materials for automotive use started to show some activity in 2010. We estimate that this market will grow in 2011, to nearly $300m (almost ¥27bn), tracking the rise in EV production. After that, we think the market will expand steadily and enter a major growth phase in or around 2015, enabling market sales to reach about $2.7bn (almost ¥220bn) in 2015. We expect the market for automotive applications to become larger than the market for small consumer electronics applications in 2017. We anticipate steady ongoing growth in the automotive applications market through 2020, with market scale reaching nearly $11bn (nearly ¥920bn).

Figure 50: Auto-use LiB main materials sales trends



Source: Advanced Automotive Batteries, USABC and Deutsche Bank Group estimates

Major LiB materials: Historic trends and outlook

Competitive conditions and profitability varying by material type

The pace of market expansion varies considerably by component-material (because of differing internal cell design, competitive conditions, and other factors). Growth basically mirrors the EV market, however. Current conditions and future trends for components-materials are summarized in Figure 51. Major points are as follows.

1. Cathode materials: This is the most crowded field. Many new entrants from China and other countries have entered the market. There are several types of cathode materials. No favorites for automotive applications have emerged yet. We think the risk of price reductions is relatively high, given that these are the most expensive battery materials and the high number of suppliers. Even in consumer applications, profit margins have been falling. We think it will be difficult to attain high margins from automotive applications.

2. Anode materials: Japanese makers largely monopolize the market, and the technological barriers to market entry are high (especially for automotive applications). We think the threat of new entrants from China and other Asian countries are low at this time. Natural graphite anode materials are the main input for automotive applications, but most graphite reserves are in China, and diversifying suppliers is an urgent requirement. We understand makers are working actively to develop materials without natural graphite that have good performance features and are cost-competitive.

3. Separators: Companies are apparently focusing resources on the research and development of cost-competitive dry processes for automotive applications. Although risks that local Chinese makers will emerge are low, major Korean battery makers have been gradually increasing their share of domestic supply. In automotive applications, the technological barriers to entry are high, and market share changes little compared with consumer electronics. Separators require advanced engineering in such areas as film deposition and extension, and marginal profit ratios are high.

4. Electrolyte solution: Marginal profit rates are higher for electrolyte solution and electrolyte (its main component) than for other component materials. There are now only two or three suppliers of high-grade electrolyte, and the technological barriers to entry are high. Most raw material supply for electrolyte production is from China, however, posing supply risks. Korean companies may keep their production of electrolyte solution in-house. We understand that production volume, particularly low-grade output, is rising in China. R&D trends for automotive applications merit close monitoring.

Figure 51: Major LiB materials – Historic trends and outlook

	Deutsche Sec. estimates (¥bn)							
	2009	2015	2020					
	Market size (mainly consumer)	Auto-use market size	Auto-use market size	Major makers (current)	Top 3 firms' market share(%)	Japanese makers' share(%)	New entrants (incl. projections)	Foreign competition/risks
Cathode material	170-190	119	490	Nichia, Umicore AGC Seimi Chemical Tanaka Chemical, Toda Kogyo, Nippon Chemical Industrial, Nippon Denko, Sumitomo Metal Mining	40-50% approx.	70-80%	Mitsubishi Chemical HD, Tosoh, Sumitomo Chemical	・Concern about margin decline due to flood of Chinese local makers
Anode material	29-34	34	140	Hitachi Chemical JFE Chemical Nippon Carbon Mitsubishi Chemical HD	Just over 70%	Virtually a monopoly	Kureha, Showa Denko, Tokai Carbon	・Natural graphite is unevenly distributed toward China, etc, fencing in of resources, etc
Separator	48-52	44	179	Asahi Kasei Celgard(US) Tonen Chemical/Toray Ube Industries SK Innovation (Korea)	85% approx.	Just under 70%	Sumitomo Chemical, Mitsubishi Chemical HD, Teijin, Chisso	・Major South Korean battery makers step up domestic procurement
Electrolyte solution	37-40	32	132	Ube Industries Mitsubishi Chemical HD Tomiyama Pure Chemical Industries Panax E-tec(Korea) LG Chemical Shanshan TECH(China)	80% approx.	60% approx.	Central Glass, Showa Denko	・Development of in-house manufacturing at major South Korean battery makers ・Decline in market share of Japanese battery makers
Electrolyte	11-12	13	52	Kanto Denka Kogyo Stella Chemifa Morita Chemical Industries	95% approx.	95% approx.	Central Glass, Foosung(Korea)	・Hike in Chinese custom duties on major raw material (hydrofluoric acid) ・Inflow of technology to China

	Market trends, etc.	Trends in automotive uses
Cathode material	・Apparently, there are 7-10 local Chinese makers. Korean battery makers shift to strengthen in-house production. ・It seems that Samsung SDI and LG Chemical are currently increasing procurement from China to reduce costs. ・Apparently, the overseas share of Japanese makers is declining, due in part to impact of strong yen. ・Market newcomers are also increasing, and margins are tending to decline.	・Nissan Leaf has reportedly used manganese materials ・US and Chinese battery makers are focusing on iron materials ・Unclear which type will become mainstream at present
Anode material	・Market monopolized by Japanese, and threat of entry by Chinese and South Korean firms is currently low, in our view. ・For makers that intend to enter the market with low-grade products, this is a material with relatively high-performance requirements with large capex outlays so the barrier to entry is high. ・There are probably 1-2 local Chinese makers, but there seem to be no striking moves.	・There is more need for the inexpensive natural graphite type than the high-priced artificial graphite type, and it appears a hybrid type combining the two has also been developed.
Separator	・SK Innovation is supplying two major South Korean battery makers and its share seems to be rising steadily. ・Dry type, which is cost competitive and handled by Celgard and Ube Industries, is the de facto standard in China. ・Chinese local makers are not very actively involved and there seem to be one or two firms only. ・Following successive ignition accidents in the past, high-performance membranes, which have strong heat resistance, are also attracting market attention.	・As dry process is cost competitive, it may become the industry standard, and various companies are hurriedly developing dry processes for auto-use ・However, it seems the wet type is also being used
Electrolyte solution	・Major South Korean battery makers such as Samsung SDI and LG Chemical are promoting a "Buy Korea" campaign. ・There are about 4 Chinese local makers, producing mainly low-grade products. ・Japanese firms mainly supply domestic battery makers. In process of doing automobile-related sample work. ・Some firms are trying to strengthen their cost competitiveness by manufacturing electrolyte material and additives, etc in house.	Required grades vary according to each battery maker, and companies are in the process of shipping samples
Electrolyte	・Foosung is apparently attempting to boost its share of business with South Korean battery makers. ・There are currently no Chinese makers and probably at R&D stage. Chinese electrolyte makers are probably promoting in-house manufacturing; need to monitor trends at Chinese companies. However, as advanced hydrofluoric acid technology is required, we think it will take time to reach full-scale production. ・Chinese demand has been burgeoning in recent years; we estimate 40% Chinese demand, 30-40% Japanese demand, and 20-30% South Korean demand. ・Morita Chemical Industries' major bases may be boosting sales to low-end Chinese makers.	・Demands for high-purity products are strong and technological entry barriers are high ・Products of Stella Chemifa and Kanto Denka Kogyo are one step ahead

Source: Deutsche Securities, based on company materials and interviews

Profit trends at LiB materials companies

Separator, electrolyte margins comparatively high

Next, we examine the business results of LiB materials companies. Our analysis of earnings by LiB materials manufacturers focuses on companies where we calculate that LiB materials generate a substantial share both of total profits and of profits for the segments that include these operations.

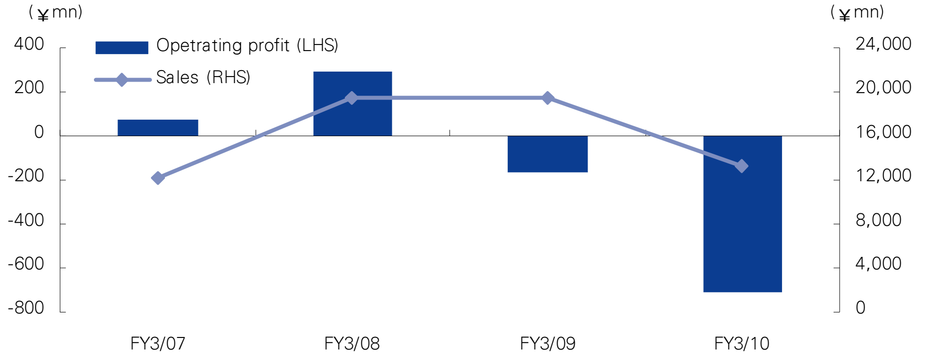
Cathode materials

The following three companies are involved in cathode materials. Toda Kogyo's electronic materials segment (including LiB materials and magnetic materials) posted a YoY decline greater than 30% in FY3/10 sales. The drop reflected a steep fall in sales prices for battery materials, which track metals prices. The segment operating loss increased to roughly ¥700m as price revisions and cuts in sourcing costs failed to offset the weaker top line. The operating line returned to a profit of almost ¥300m in 1H FY3/11. We attribute the improvement to 1) better capacity utilization due to a demand rebound caused by government stimulus measures and 2) the ongoing adoption of LiB cathode materials for automotive applications.

Tanaka Chemical's strategic products are currently ternary cathode materials. Its FY3/10 sales fell more than 30% YoY because it shifted from cathode materials using high-cost cobalt to cheaper ternary cathode materials, which required lowering of sales prices. However, the company said that its margins improved because of demand growth for ternary cathode materials, and nickel hydride battery materials for consumer products. As of 1H FY3/11, LiB materials generated just over 70% of total sales, and materials for nickel hydride batteries the remainder.

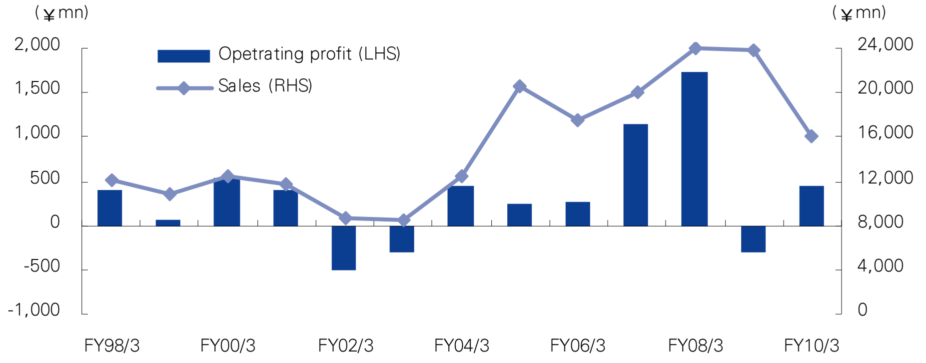
Nippon Denko's advanced materials segment (including lithium manganese oxide for LiB; ferroboron; and zirconium oxide) posted sales and OP drops of roughly 30% YoY in FY12/09 (calendar year base). Demand for lithium manganese oxide for LiB cathode materials rose YoY owing to the start of shipments to electric car, power tool and general automotive manufacturers. However, demand for other products was weak. We understand that aggregate OP for 1Q-3Q FY12/10 grew to almost ¥1.2bn (cf just over ¥200m for FY12/09) as a result of strong demand growth for lithium manganese oxide (mainly for automotive LiB) and recovery of demand for other products.

Figure 52: Toda Kogyo (Electronic Materials segment) earnings trend



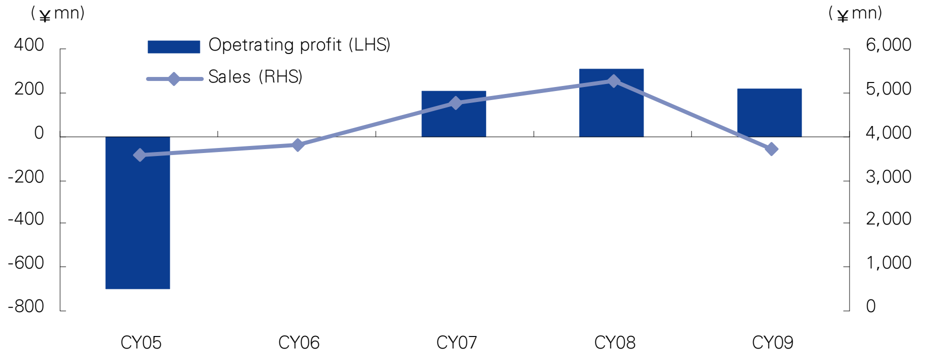
Source: Bloomberg Finance LP

Figure 53: Tanaka Chemical earnings trend



Source: Bloomberg Finance LP

Figure 54: Nippon Denko (New Materials segment) earnings trend



Source: Bloomberg Finance LP

Separator

As a result of the global financial crisis, Polypore, which has a subsidiary that makes separators, posted lower sales and OP in FY09 in its energy storage division (Polyopore has two separate business lines, with lead-acid storage batteries generating more than 70% of sales and LiB providing almost 30%). Earnings had expanded steadily in previous years. The five-year operating margin is around 20%. There was little change in the most recent quarter (3Q FY10). We think Polypore's earnings trend confirms the separator business' high profitability.

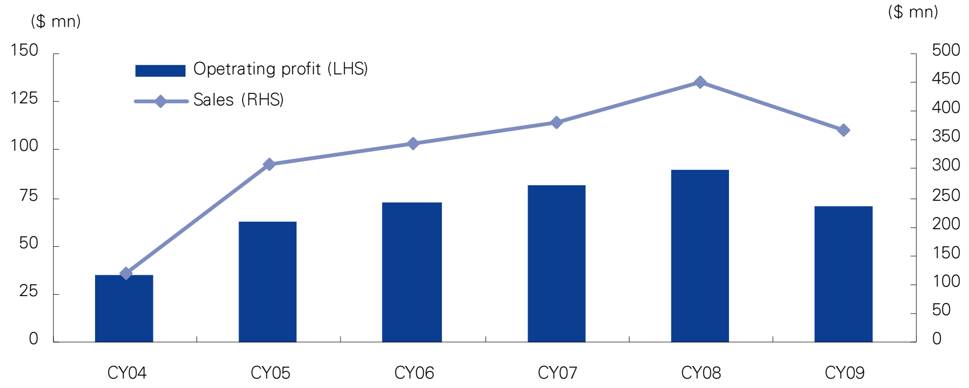
Electrolyte solutions

Kanto Denka Kogyo's fine chemicals division (before the FY3/11 reorganization) makes electrolytes and additives. It produced fine chemicals (fluoro-chemicals, battery materials) and ferro-chemicals. We estimate that electrolytes (LiPF6) generated almost 15% of segment sales. The segment operating margin was high at roughly 25.5% in FY3/07. However, stiffer competition for mainstay NF3 gas for washing semiconductors and LCD reduced it to about 3% in FY3/10. A recovery of demand for semiconductors and LCD has improved segment profits in FY311 (the segment has been reorganized to exclude ferro-chemicals): its 1H operating margin rebounded to roughly 11%. Based on discussions with the company, we think electrolytes carry higher margins than the segment overall.

Stella Chemifa's high-purity chemicals division (high-purity hydrofluoric acid generates about 50% of sales, electrolytes almost 20%, other products the remainder) is highly profitable, with an FY3/10 operating margin of almost 20%. It sustained this profitability into 1H FY3/11. Based on discussions with the company, we estimate that the electrolyte business is more profitable than the high-purity chemicals business.

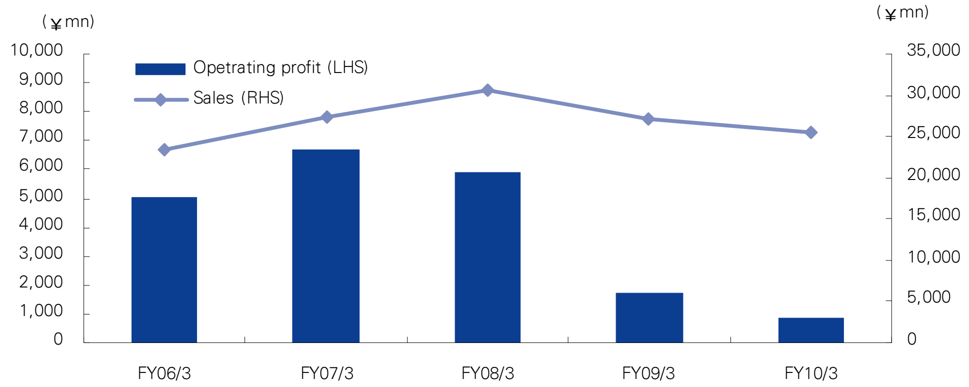
It is difficult to estimate margins for individual products based on earnings at anode materials and electrolyte solution manufacturers. However, our discussions with industry participants suggest that although the profitability of these products has weakened compared with electrolytes and separators, it is still in the double digits.

Figure 55: Polypore (Energy Storage segment) earnings trend



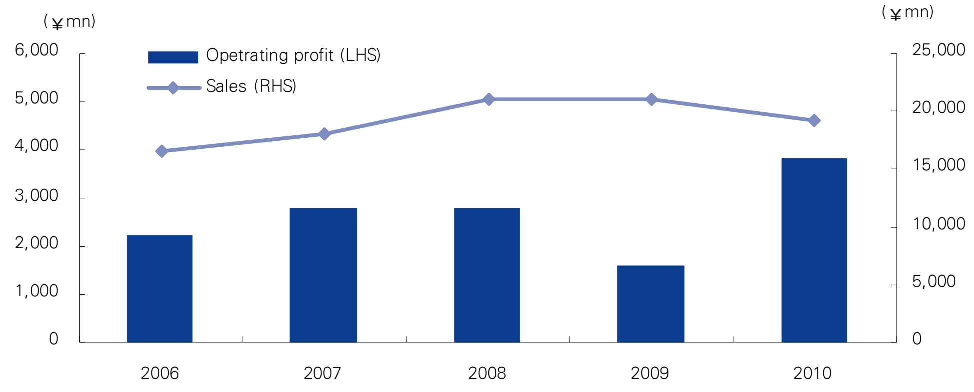
Source: Bloomberg Finance LP

Figure 56: Kanto Denka Kogyo(Fine Chemicals segment) earnings trend



Source: Bloomberg Finance LP

Figure 57: Stella Chemifa (High-grade Chemicals segment) earnings trend



Source: Bloomberg Finance LP

Japan

Paper & Textiles/Textiles

26 January 2011

Toray Industries

Reuters: **3402.T** Bloomberg: **3402 JT**

Benefiting from synergies with Tonen Chemical in the separator field

Investment rating

We retain our Buy rating on Toray. This Buy rating is supported by a better-than-expected improvement in carbon fiber profit, a recovery and rise in earnings above consensus estimates, and the medium-term growth potential of environment-related operations. While earnings are poised to renew record highs in FY3/13, the stock has dipped to a P/E of around 16x our FY3/12 forecast, close to the low end of the historical range – implying it is an attractive investment.

Tonen Chemical/Toray group rank third in global separators (20% market share)

In February 2010, TonenGeneral Sekiyu and Toray established Toray Tonen Specialty Separator Godo Kaisha, a 50-50% joint venture specializing in the production of battery separators. The joint venture believes it can quickly develop separator technologies by combining Toray's precision-processing technology for plastic film and its polymer technology with TonenGeneral Sekiyu's knowledge and engineering know-how in LiBs. Tonen Chemical, a wholly owned subsidiary of TonenGeneral Sekiyu (an ExxonMobil group company) has been in the separator business for a long time. The JV ranks third in sales worldwide with a market share of around 20%. The joint venture will be able to produce high-performance separators by using resin-processing technologies from ExxonMobil Chemical (another group company) and expertise in microporous film, a product area where Tonen Chemical is competitive.

Joint venture R&D in automotive separator field holds promise

The JV has two production plants in operation, in Nasu, Tochigi Prefecture, and Gumi, South Korea. Details about production capacity and other aspects of operations have not been disclosed. The JV mainly uses what is called the wet process in separator production, but we understand that the joint venture is also studying dry processes for automotive applications. The JV aims to generate sales of ¥40bn in 2015 and ¥80bn around 2020. It targets a market share of around 30% in 2020. At present the separator JV contributes little to profits, but we intend to closely monitor how quickly it generates synergies in the automotive LiB field.

Valuation and risks: maintaining ¥620 target price

We maintain our TP of ¥620 based on FY3/12E around P/E of 18x, accounting for our EPS estimate, five-year historical P/E and taking into account risk tolerance levels. Risk factors include: 1) further delays to the schedule for initial B787 flights; 2) falling demand for carbon fiber for aircraft as the aircraft completion rate falls; 3) a drop in demand for film as the LCD market contracts sharply; and 4) deteriorating earnings in the fiber & textiles and the plastics & chemicals segments due to spiking fuel costs.

Forecasts and ratios

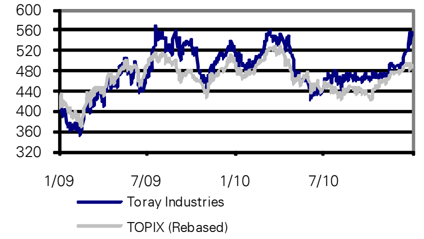
Year End Mar 31	2010A	2011E	2011CoE	2012E	2013E
Sales (¥bn)	1,359.6	**1,537.0**	1,530.0	1,585.0	1,647.0
YoY (%)	-7.6	**13.0**	12.5	3.1	3.9
Operating profit (¥bn)	40.1	**87.0**	83.0	101.0	122.0
YoY (%)	11.4	**116.9**	106.9	16.1	20.8
Recurring profit (¥bn)	9.0	**80.0**	76.0	98.0	121.0
Net profit (¥bn)	-14.2	**44.5**	42.0	56.0	70.0
EPS (¥)	-10	**27**	26	34	43
P/E (x)	-	**20.1**	20.8	16.0	12.8
EV/EBITDA (x)	10.9	**8.3**	-	7.2	5.9
CFPS (¥)	43	**71**	-	79	89
P/CFPS (x)	11.3	**7.7**	-	7.0	6.2

Source: Deutsche Securities Inc. estimates, company data

Buy

Price at 25 Jan 2011 (¥)	**549**
Price target - 12mth (¥)	**620**
52-week range (¥)	**558 - 423**

Price/price relative



Performance (%)	1m	3m	12m
Absolute	*12.7*	*17.6*	*6.8*
TOPIX	*3.1*	*13.2*	*-0.6*

Stock data

Market cap (¥bn)	**895**
Shares outstanding (m)	**1,629**
Foreign shareholding ratio (%)	**17.1**
TOPIX	**929**

Key indicators (FY1)

ROE (%)	**8.4**
BPS (¥)	**362**
P/B (x)	**1.5**
EPS growth (%)	**–**
Dividend yield (%)	**0.9**

Japan

Chemicals Chemicals/Basic Chemicals

26 January 2011

Asahi Kasei

Reuters: **3407.T** Bloomberg: **3407 JT**

Autos: Maker looks to leverage lead in consumer electronics separators

Investment rating

We reiterate our Buy rating, because: 1) earnings improvement should outstrip management's expectations, 2) we view lithium battery materials as having strong medium-term potential, and 3) housing orders should continue to recover and expand.

Commanding share, exceeding 40% in global separator sales

Asahi Kasei has the top global share, commanding more than 40% of the separator market. Most production uses the wet process that is mainly for consumer electronics such as mobile phones and notebook PCs. For automotive applications, the company jointly develops separators with automakers in Japan and abroad, and anticipates the early, large-scale adoption of its products by auto assemblers. Its two domestic plants – in Moriyama, Shiga Prefecture, and Hyuga, Miyazaki Prefecture – have a combined capacity of about 170m square meters annually. Management plans to gradually increase capacity to 200m square meters by June 2011. The company is likely considering major production using dry processes for automotive LiBs in addition to the wet processes it now uses as, according to management, dry processes are already being developed and have reached the marketing stage.

Looking for contribution in five years time of ¥35-40bn to sales, ¥8-12bn to OP

Asahi Kasei is building a separator processing plant in Korea, which should come on line in 2H 2011. Film produced in Japan will be cut and processed into separators shaped for end-use products at the Korean plant. By processing separators tailored to customer demand, delivery times can be greatly reduced. Meanwhile, Samsung SDI, LG Chem and other Korean battery makers plan to increase capacity, and this is unlikely to be positive for separator demand at Asahi Kasei, given that Korean companies have not internalized much of their production. We estimate FY3/10 separator sales came to ¥20-30bn and assume an operating margin of 20-30%. We project FY3/16 sales of ¥35-40bn and OP of ¥8-12bn, factoring in growth in demand from consumer electronics devices, as well as automobiles.

Valuation and risks: retaining ¥630 target price

Our TP remains unchanged at ¥630 (we apply a multiple of 12x FY3/12E average P/E for listed petrochemicals stocks based on consensus estimates and our own estimates). Risk factors include softer petrochemical demand in China, earnings deterioration in the electronics segment due to a larger-than-expected decline in mobile phone production, falling housing orders due to rising interest rates and the termination of policy measures, and the yen's appreciation (We note that a ¥1 change in the yen's value against the dollar results in Asahi Kasei's OP changing ¥600-800m a year, while a ¥1 change against the euro results in OP changing by ¥100m).

Forecasts and ratios

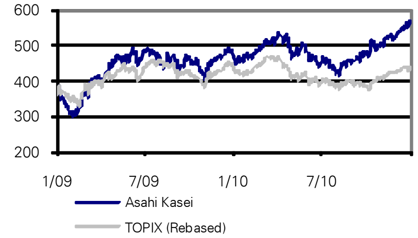
Year End Mar 31	2010A	**2011E**	2011CoE	2012E	2013E
Sales (¥bn)	1,433.6	**1,624.0**	1,608.0	1,723.0	1,764.0
YoY (%)	-7.7	**13.3**	12.2	6.1	2.4
Operating profit (¥bn)	57.6	**125.0**	115.0	134.0	145.0
YoY (%)	64.8	**116.9**	99.6	7.2	8.2
Recurring profit (¥bn)	56.4	**121.0**	110.5	133.0	145.0
Net profit (¥bn)	25.3	**64.0**	58.5	73.0	79.0
EPS (¥)	18	**46**	42	52	56
P/E (x)	25.2	**12.5**	13.6	10.9	10.1
EV/EBITDA (x)	5.6	**4.5**	-	3.9	3.4
CFPS (¥)	80	**110**	-	114	119
P/CFPS (x)	5.7	**5.2**	-	5.0	4.8

Source: Deutsche Securities Inc. estimates, company data

Buy

Price at 25 Jan 2011 (¥)	**571**
Price target - 12mth (¥)	**630**
52-week range (¥)	**571 - 415**

Price/price relative



Performance (%)	1m	3m	12m
Absolute	*10.2*	*19.2*	*22.3*
TOPIX	*3.1*	*13.2*	*-0.6*

Stock data

Market cap (¥bn)	**798**
Shares outstanding (m)	**1,398**
Foreign shareholding ratio (%)	**22.5**
TOPIX	**929**

Key indicators (FY1)

ROE (%)	**9.8**
BPS (¥)	**479**
P/B (x)	**1.2**
EPS growth (%)	**153.1**
Dividend yield (%)	**1.8**

Japan

Chemicals Chemicals/Basic Chemicals

26 January 2011

Mitsubishi Chem. Holdings

Reuters: **4188.T** Bloomberg: **4188 JT**

World’s only maker of all four major materials; custom-tailored solutions are its advantages

Investment rating

We reiterate our Buy rating as we expect earnings to continue to improve sharply, aided by corporate acquisitions and restructuring, especially in the petrochemicals business. The stock looks undervalued at a forecast FY3/12 P/E of just under 9x.

Synergy from four major materials as maker sets sights on customer needs

Cathode materials were commercialized in 2005. Along with traditional cobalt-based cathode materials, the company produces ternary compounds. Its proprietary particle design enhances output and durability. It added new production lines at Mizushima in Nov 2010, and annual capacity is 2,200 tons. Mitsubishi Chemical targets a capacity of 15,000 tons for cathode materials and a market share of 10% by 2015. Anode materials are made from natural or artificial graphite and while present capacity is 5,000 tons annually, it aims to raise capacity to 7,000 tons by May 2011. All manufacturing bases are in Japan but it plans to add new facilities in China. Output is expected to be 4,000 tons annually after new facilities start-up in Mar 2012. A JV has been set up in China for spherical graphite, the main ingredient in anode material, and new facilities with output of 2,000 tons annually are to go on-line in May 2011. Chinese production facilities can maintain cost-competitiveness through integrated production, ranging from spherical graphite (raw material) to anode material. The company plans to build a network with an annual capacity of 35,000 tons by 2015 and targets a market share of 35%. Separately, for electrolyte solutions, Mitsubishi Chemical targets market share growth from 25% to 40% by raising output from 8,500 tons to 50,000 tons. It is noted for modifying production to meet customer needs by offering highly durable additives and other chemicals in different combinations. It began producing separators in 2003 and was a latecomer. It develops products based on material design technologies and film deposition technologies that have been improved over many years. The company says it can generate output with strengths acquired from the wet process and at the cost of the dry process. It has its sights on products tailored for high output and expects to enter the automotive application field. The plan is to raise annual production from 12m square meters to 72m by 2015.

Valuation and risks: maintaining ¥800 target price

Our ¥800 TP is based on FY3/12E P/E of 12x, the avg. for the listed petrochemical companies (using market consensus and our forecasts). Risks are a slowdown in China, delays in petrochemical industry realignment, greater-than-expected erosion in FPDs, a sharp drop in cotton (gauging from the price differential relative to polyester fiber, demand for synthetic fiber raw material would not be greatly affected if the price falls from the present $1.50/lb to around $1.10/lb), and stock dilution due to equity financing because of balance sheet erosion.

Forecasts and ratios

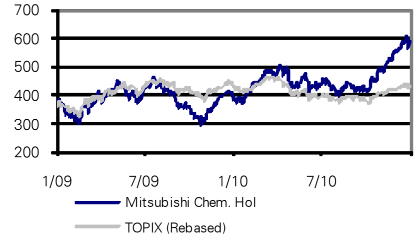
Year End Mar 31	2010A	2011E	2011CoE	2012E	2013E
Sales (¥bn)	2,515.1	**3,211.0**	3,190.0	3,328.0	3,403.0
YoY (%)	-13.5	**27.7**	26.8	3.6	2.3
Operating profit (¥bn)	66.3	**215.0**	203.0	234.0	249.0
YoY (%)	711.2	**224.1**	206.0	8.8	6.4
Recurring profit (¥bn)	59.0	**209.0**	196.0	229.0	244.0
Net profit (¥bn)	12.8	**82.0**	75.0	92.0	96.0
EPS (¥)	9	**60**	53	67	70
P/E (x)	42.3	**9.9**	11.2	8.8	8.5
EV/EBITDA (x)	9.3	**5.3**	-	4.7	4.2
CFPS (¥)	104	**169**	-	183	186
P/CFPS (x)	3.8	**3.5**	-	3.2	3.2

Source: Deutsche Securities Inc. estimates, company data

Buy

Price at 25 Jan 2011 (¥)	**591**
Price target - 12mth (¥)	**800**
52-week range (¥)	**605 - 369**

Price/price relative



Performance (%)	1m	3m	12m
Absolute	*8.0*	*40.7*	*53.1*
TOPIX	*3.1*	*13.2*	*-0.6*

Stock data

Market cap (¥bn)	**813**
Shares outstanding (m)	**1,375**
Foreign shareholding ratio (%)	**16.0**
TOPIX	**929**

Key indicators (FY1)

ROE (%)	**11.7**
BPS (¥)	**526**
P/B (x)	**1.1**
EPS growth (%)	**539.4**
Dividend yield (%)	**1.7**

Figure 58: Mitsubishi Chemical HD production increase plans to 2015

	Existence Capacity (as of end-2010)	Target capacity (2015)	Expansion location targets	Shares(%) 2009→2015	Distinction and competitive advantage
Electrolyte solutions	8,500ton/year	50,000ton/year	Domestically and abroad	25→40	•Abundant knowledge and patents for additive •Synergy with other materials
Anode active materials	5,000ton/year	35,000ton/year	Domestically and abroad	20→35	•Spheronization technology for graphite •Property improvements by surface modification
Cathode active materials	2,200ton/year	15,000ton/year	Domestically	<5→10	•Development of materials with less cobalt •Power, durability improvements by own particle design
Separator	12mil.m^2/year	72mil.m^2/year	Domestically	<5→10	•Cycle life, power, conservation property improvements through its dry 3D structure

Source: Company data

The company's LiB materials business belongs to its Designed Materials segment. In FY3/10, LiB materials sales came to nearly ¥14bn, and mainly comprised electrolyte solutions. We expect sales to rise to around ¥15bn in FY3/11 and ¥18bn in FY3/12. The company aims to expand the business aggressively, targeting FY3/16 sales of ¥80bn and an increase in its overall materials market share from just over 5% to around 20%. It intends to invest ¥30bn into expanding the business over the next five years, with plans in the immediate future to step up investment into its electrolyte solutions operations and establish sales and manufacturing companies in the UK and US. It may already have been selected as a supplier by overseas companies as well as Japanese companies with overseas production plants. LiB materials do not appear to make a noticeable profit contribution at the moment, but we look for OP from this business to grow to ¥15-18bn over the next five years. In our view, the company needs to step up development of separators, an area where it has lagged the competition.

Japan

Chemicals Chemicals/Specialty Chemicals

26 January 2011

Hitachi Chemical

Reuters: **4217.T** Bloomberg: **4217 JT**

Major technological edge in anode materials, scope for substantial profit contribution going forward

Investment rating

We retain our Buy rating, given strong growth in the LiB business, and accelerating expansion of the automotive materials business worldwide. The shares appear undervalued, trading at a P/E of 12x our FY3/12 forecast.

Global share surpassing 40% in anode materials sales

Asahi Kasei is the leading global maker of anode LiB material and has a global share of 45%. It is adept at supplying materials for small consumer electronics that require high capacity. Thanks to its proprietary carbon technology, which has been improved through the development of motor brushes and other products, the company is competitive in high-performance areas. In the automotive LiB field, management has singled out the development of automotive applications, including the anode materials business for environmentally clean autos, as a key part of its fiscal 2010 plan. Sales from automotive applications are on the rise, but are still relatively low. However, in anticipation of higher demand, the company has doubled its capacity after bringing new production facilities on line in December 2010. Also, it plans capex of around ¥10bn to raise production for materials for consumer applications and to add new production facilities for environmentally clean automotive applications. We estimate this segment's sales came to ¥12bn in FY3/10 and contributed to 5-10% of total profit, but by FY3/13 we expect sales to grow to around ¥20bn and OP to rise to ¥4-5bn.

Alliance with Germany's SGL Group prompts entry into European market

At the end of June 2010, Hitachi Chemical and SGL Group of Germany (a leading global specialty carbon and carbon graphite maker) announced a comprehensive alliance in the auto and industrial LiB anode materials business for Europe. Among the key LiB materials, while SGL already has a supply network in Europe for cathode materials and separators, it lacks a supply base for anode materials. The two-party alliance thus aims to create a production and supply network for the European market. Also, they will form a long-term partnership in the consumer electronics LiB field by making full use of SGL's production technologies and abundant production capacity in Europe, and Hitachi Kasei's R&D capabilities and applied products technologies.

Valuation and risks: retaining ¥2,100 target price

Our ¥2,100 TP is based on FY3/12E P/E of 15x, the average of listed LCD and semiconductor firms, using the market consensus and our forecast. Risks are a further slowdown in the semiconductor market, greater-than-expected profit erosion for advanced semiconductor and LCD materials due to stiffer competition, poorer profits in the brake, molding materials and battery businesses due to lower auto output, and a stronger yen (a ¥1 move against the dollar has an annual impact on OP of ¥700m).

Forecasts and ratios

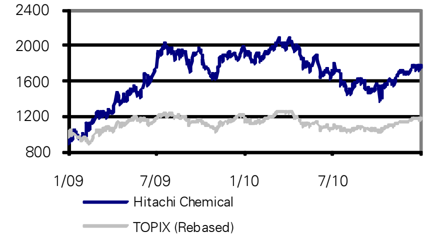
Year End Mar 31	2010A	**2011E**	2011CoE	2012E	2013E
Sales (¥bn)	455.3	**498.0**	500.0	518.0	539.0
YoY (%)	-6.8	**9.4**	9.8	4.0	4.1
Operating profit (¥bn)	38.3	**44.0**	44.0	47.5	52.0
YoY (%)	92.3	**14.8**	14.8	8.0	9.5
Recurring profit (¥bn)	36.5	**44.0**	44.0	48.0	53.0
Net profit (¥bn)	23.5	**26.5**	26.5	29.5	32.5
EPS (¥)	113	**127**	127	142	156
P/E (x)	15.3	**14.0**	14.0	12.5	11.4
EV/EBITDA (x)	5.0	**4.6**	-	4.1	3.5
CFPS (¥)	265	**271**	-	293	312
P/CFPS (x)	6.5	**6.5**	-	6.1	5.7

Source: Deutsche Securities Inc. estimates, company data

Buy

Price at 25 Jan 2011 (¥)	**1,777**
Price target - 12mth (¥)	**2,100**
52-week range (¥)	**2,090 - 1,368**

Price/price relative



Performance (%)	1m	3m	12m
Absolute	*6.0*	*13.8*	*-8.0*
TOPIX	*3.1*	*13.2*	*-0.6*

Stock data

Market cap (¥bn)	**370**
Shares outstanding (m)	**208**
Foreign shareholding ratio (%)	**19.2**
TOPIX	**929**

Key indicators (FY1)

ROE (%)	**9.6**
BPS (¥)	**1,353**
P/B (x)	**1.3**
EPS growth (%)	**12.7**
Dividend yield (%)	**2.0**

Major material makers

Cathode material makers

Nichia (unlisted)
Nichia is developing and producing LiB cathode material using powder synthesis technology, leveraging its many years of experience producing phosphors. The company's strengths lie in integrated production beginning with raw materials. It started volume production of cobalt-based cathode material in 1996. It now produces manganese-based and ternary materials. Operations are being expanded to cover portable digital equipment, power tool, and car battery applications. Sanyo Electric is likely the main customer. Production capacity has not been disclosed, but the company reportedly has a high global share in cathode material sales.

Umicore (UMI.BR, Buy, TP EUR46, lead analyst: Martin Dunwoodie)
Umicore is a leading Belgium-based producer of functional materials. The company produces automotive catalysts, energy-related materials (for rechargeable batteries, fuel cells, etc), and other products using cobalt, nickel, and other nonferrous metals. It has production plants for LiB cathode material in Korea and China that reportedly supply major battery makers in both countries. Production capacity is 7,500 tons annually at the Korean plant (China plant capacity is unknown). It plans to build a production plant for LiB cathode material in Kobe that is scheduled to begin operating in June 2011. We understand that supply capacity will be 3,000 tons annually and total investment costs are around ¥4bn.

Toda Kogyo (4100.T, NR)
Toda Kogyo's broad lineup of cathode materials includes nickel, manganese, ternary, and cobalt-based products. The company has the largest share of nickel-based material sales. Regarding LiB cathode material (its top future priority), the company is reportedly withdrawing from the small consumer electronics field and focusing resources on automotive applications and other larger fields. The automotive cathode material business has already started operating and is apparently generating sales and earnings. Cobalt-based material has been the main product, but management's strategic focus is now on promoting nickel, manganese, and ternary-based materials for eco-cars. Toda Kogyo's manganic acid materials are used by major domestic automakers, and Hyundai Motor and Ford in the US are reportedly using part of the output. The production network consists mainly of nickel, manganese, and ternary materials plants in Japan. The company plans to increase output to 5,000 tons annually in 2012.

In addition, Toda Kogyo appears to be aggressively expanding overseas in the current fiscal year. Its American subsidiary has received a grant for $35m from the US Department of Energy for LiB and component production. It plans to increase cathode material production (principally cobalt and ternary-based) through a joint venture with Itochu. It aims to steadily increase production through 2013 and ultimately raise it to 4,000 tons annually. As for Chinese business development, the company and Itochu have announced a joint investment in Hunan Shanshan Advanced Material (HSAM) which supplies LiB cathode material to major Chinese battery makers (we understand the capital connection was finalized in December). The partners aim to strengthen production capacity from 4,000 tons now and steadily increase the product lineup. HSAM is a wholly owned subsidiary of Ningbo Shanshan (a member of the Shanshan group), which has LiB materials-related cathode and anode material and electrolyte solution plants under its wing and has been described as China's most comprehensive battery component-materials maker.

Tanaka Chemical (4080.OS, NR)

Tanaka Chemical is a major producer of ternary cathode material that is apparently shipped widely to Japanese and overseas battery makers. Plans to raise production capacity of cathode material from 6,000 tons annually to 11,000 tons are scheduled for completion in March 2011. We understand that capex will total ¥6.6bn, the company's biggest investment outlay ever. New facilities are mainly targeting LiB cathode materials for use in automobiles. Sample shipments for auto use are being made, but automakers require that materials makers have production systems capable of some shipments beginning from the user testing phase (securing stable supply is important in light of expectations that volume will be much higher than for consumer electronics applications). For this reason, production capacity is being nearly doubled. Tanaka Chemical and the Industrial Technology Research Institute are jointly developing cathode materials that do not include cobalt as promising next-generation materials. The company is a leading producer of cathode material for nickel hydride batteries used in hybrid cars.

Nippon Denko (5563.T, NR)

Nippon Denko is a major producer of ferroalloy (steel alloy) for Nippon Steel. In 2002, it acquired Japan Metals & Chemicals' lithium manganese spinel (LMS) business and entered the LiB cathode material field. The company uses proprietary technology to produce manganese-acid lithium cathode material with superior longevity. We understand it is used widely in portable electronic devices, power-assist bicycles, power tools, and other products. The company started supplying production for large batteries installed in hybrid electric cars in 2010. Supply capacity is 2,700 tons annually. A second large production plant is under construction. Output will be used to meet surging demand for electric cars. The plant is scheduled to begin operating in February 2011 with total production capacity of 6,700 tons after operation begins.

Anode material makers

JFE Chemical (JFE Holdings affiliate, unlisted)

JFE Chemical is a wholly owned subsidiary of JFE Steel, an affiliate of JFE Holdings. The company produces anode material from graphite spherulites using coal-tar pitch, a by-product of the steel production process. Because of the nature of the spherical graphite powder produced, voids which are necessary for batteries are formed and it is possible to have high packing density and high capacity. The company's R&D network is reportedly being strengthened in preparation for entering the automotive applications market. Management has not disclosed plans for increasing capacity.

Nippon Carbon (5302.T, Hold, TP: ¥270, lead analyst: Katsuhiko Ishibashi)

Nippon Carbon produces carbon materials, electrodes for steelmaking, and other specialty carbon products, and carbon fiber products. The company is a major producer of artificial graphite electrodes and has the world's largest integrated production facilities for artificial graphite-type anode material.

Kureha (4203.T, NR)

Kureha produces hard carbon-based anode material based on activated carbon technologies that use oil pitch as a raw material. Hard carbon-based material is noted principally for use in products requiring charge-discharge properties and durability (large LiBs for industrial use). It is not used much in consumer electronics. As industrial applications, materials are used in commercial video cameras and other products. Production capacity is 600 tons annually. The company has unveiled plans to increase capacity to 1,600 tons by early 2012 to meet rising demand for LiBs for automotive use. The company plans to supply LiB anode material for EVs to EnerDel, a US maker of LiBs for installation in autos. EnerDel is a wholly owned subsidiary of Ener1 (a Nasdaq stock). The company has an integrated production network extending from cells to battery systems in the US. It has contracts to supply batteries to THINK of Norway and Volvo of Sweden.

Showa Denko (4004.T, NR)

Showa Denko produces anode material for LiBs based on proprietary production technologies for artificial graphite powder (heat treatment, pulverization, and classification). The company is the first anode material maker worldwide to generate sales and earnings from EV applications. It plans to increase production capacity, mostly for automotive use, from 1,000 tons annually to 3,000 tons in 2012. Management established the advanced battery materials division in 2009. Its medium-term business plan (2011-2015) unveiled in 2010 assigns importance to strengthening the LiB materials business. It targets growth in sales of advanced battery materials to ¥60bn annually by 2020. The company also produces carbon nanotubes for aiding conductivity. These are mostly used as additives for cathode and anode materials. Products improve cycle characteristics, durability, and other battery functions.

Sumitomo Bakelite (4203.T, Hold)

Sumitomo Bakelite is entering the anode material business in earnest by taking advantage of technology accumulated from its well-established phenol business. The company aims to differentiate its graphite-based material and oil-pitch hard carbon (for which the company has high market shares) from other offerings for commercializing hard carbon-based (phenol-based) materials. It mainly targets EV applications. The ability to control molecular weight is a major advantage of phenol resins.

Osaka Gas Chemical (Osaka Gas affiliate, unlisted)

Osaka Gas Chemical produces carbon fiber and carbon composite materials with carbon-based pitch as a raw material based on proprietary technology in the coal-chemical field. The company's R&D on LiB anode material, centered on production and technological upgrades for coal-based pitch, have yielded commercially viable products. Its anode materials now under development have carbon graphite with high output and durability making them suitable for eco-cars.

Separator makers

Celgard (US) (wholly owned subsidiary of Polypore International, unlisted)

Celgard is a wholly owned subsidiary of Polypore International of the US, a producer of functional membranes. It pioneered the commercialization of LiB separators. Celgard traces its roots to Celanese's separator business. It was later acquired by Polypore. Today, Celgard is the leading producer of dry-process separators and supplies output under license to Ube Industries. It acquired a Korean company with core production of wet-process separators (Yurie-Wide, for around $2.3bn) in 2008. Dry separators are the main product, but Celgard is strong in both wet and dry processes. The company is well positioned to take advantage of close ties with Korean battery makers following the buyout.

Ube Industries (4208.T, NR)

Ube Industries mainly produces dry-process separators using technology licensed from Celgard. Its core market is Chinese consumer electronics. Demand for high-capacity LiBs has been rising. Demand for dry-process separators, which have greater capacity than wet-process separators, is expected to rise in tandem with growing demand for automotive applications. The company aims to tap into this demand and attain growth.

Teijin (3401.T, Buy)
Teijin is working to develop and quickly commercialize aramid fiber separators using production and processing technology for aramid fibers. Teijin has a high market share in these fibers. Demand for aramid fibers is apparently rising because their superior heat-resistance is a safeguard against the fires, which have frequently occurred in LiBs. The company plans to make investments and start full production during 2011 with the aim of using output for consumer electronics applications.

Sumitomo Chemical (4005.T, Buy)
Sumitomo Chemical is noted for its heat-resistant separators that combine polyolefin substrates developed using proprietary technology with heat-resistant aramid layers. The company plans to increase production capacity for consumer electronics applications in 2011 and is reportedly conducting R&D on automotive applications.

Chisso (unlisted)
In July 2010, Chisso began developing LiB separators, and it has started user work for battery makers. Pilot facilities will begin operating in March 2011, and the company plans full production from 2012. It is jointly developing high-performance LiB separators with Porous Power Technologies of the US and hopes to ship output for automotive applications. Chisso announced that a joint venture will be established with Starck, of Germany, to produce and market cathode materials and undertake R&D. In early 2012, the company plans to finish building production facilities with capacity of 1,000 tons annually.

Electrolyte solution makers

Ube Industries (4208.T, NR)
Ube Industries is focusing resources on sales to high-end customers. Most output is currently for small consumer electronics applications. In this field, the strategy is to stand apart from rivals by producing high-performance and high-quality functional electrolyte solutions with the aim of generating stable profits. In the automotive field, the company plans to ramp up production capacity of electrolyte solution considerably in preparation for eco-car demand starting in 2013-2014. It is internalizing production of key raw materials for electrolyte solutions (DMC, MEC, DEC, additives) using its own technologies and bolstering quality control of raw materials.

Central Glass (4044.T, Hold, TP ¥420, lead analyst: Katsuhiko Ishibashi)
Central Glass' trial plant has annual capacity of only several hundred tons now, but the company suggests it will reach 5,000 tons in 2011, when it is scheduled to come fully on stream. It has produced fluorine products for a long time and is noted for its comprehensive production system extending from raw-material hydrofluoric acid to electrolyte and electrolyte solution. Although a latecomer to the electrolyte solution field, Central Glass' strategy is to increase market share through cost-competitiveness. It has decided to establish a joint venture with a major Chinese chemical producer for electrolyte. The company plans to begin operating a new production facility in China in mid-2012. Production capacity will be 10,000 tons annually using the standard measure for electrolyte solution. Since the Chinese partner is a major producer of solvents for batteries, the company believes it can secure stable orders for high-quality products, making its comprehensive production network for electrolyte solution stronger.

Showa Denko (4004.T, NR)
Showa Denko is actively promoting R&D of electrolyte that has greater stability than established products. It has entered the market for electrolyte solution for large LiBs installed in cars. Management says it wants to develop next-generation electrolyte solutions for cars

and quickly build a network for volume production by combining new technologies for electrolyte from Air Products of the US with its own proprietary technology for electrolyte solution. The company targets sales of ¥60bn in 2020 in the advanced battery field, including anode material for automotive LiBs. It is reportedly poised to begin sample shipments with the aim of starting volume production, especially of electrolytic solution for eco-cars, in 2012.

Mitsui Chemicals (4183.T, Buy)
Toagosei and Mitsui Chemicals announced the formation of a joint venture in April 2010 to produce ethylene carbonate (EC), a raw material in electrolyte solutions for LiBs. LiB demand has been increasing worldwide for consumer electronics applications and in conjunction with greater production of eco-cars. This is expected to sharply increase EC demand beginning in 2012. In autumn 2011, the company plans to finish building production facilities with capacity for electrolyte solution totaling 5,000 tons annually. Mitsui Chemicals will supply ethylene oxide (EO), an EC raw material, and Toagosei will produce output using its own EC production technology.

Electrolyte makers

Kanto Denka Kogyo (4047.T, NR)
Kanto Denka Kogyo is a formidable producer of specialty gases (nitrogen trifluoride, NF3) for etching gas) used in semiconductors and LCD production. The company can produce high-purity electrolyte for LiBs using its high-purity refining technology beginning at the hydrofluoric acid stage and by the so-called direct fluorination method. Its electrolyte production capacity is now 1,300 tons annually, but it plans to raise capacity to 2,000 tons in May 2011 in anticipation of growing demand for EVs and HEVs. In this field, the company and Stella Chemifa have commanding market shares. Previously, most shipments were to domestic electrolyte solution makers, but demand has been brisk from Chinese and Korean solution makers in recent years. Electrolyte sales shares are Japan 40%, China 40%, and Korea 20%. The company also produces fluorethylene carbonate (FEC) additives. Production capacity is 250 tons annually. According to FEC, it appears poised for growth in FY3/12 onward in light of growing demand for its use in eco-cars.

Stella Chemifa (4109.T, NR)
Stella Chemifa is the world's leading maker of hydrofluoric acid. Its global share is around 70% for semiconductor applications. The company mainly produces high-purity hydrofluoric acid for semiconductor and LCD washing. It has competitive technologies for special grade products, such as highly pure products. It also produces electrolyte (LiPF6) for LiBs utilizing advanced high-purity hydrofluoric acid. The company and Kanto Denka Kogyo are the two leaders in the field, as noted. Production capacity is now 1,300 tons annually. The company plans to increase it to 2,600 tons by 2011.

Morita Chemical Industries (unlisted)
Morita Chemical Industries is a major producer of hydrofluoric acid and is focusing business development on China. Its manufacturing base for electrolyte in China has production capacity of 1,200 tons annually. In 2011, the company plans to increase total production capacity to 2,000 tons. In the future, assuming that demand rises (especially in China), the company reportedly plans to build a production network with 4,400 tons of capacity.

Binder makers

Zeon (4205.T, Hold)

Zeon manufactures water binders with styrene butadiene rubber (SBR) bases. Its products are used by the four major battery makers, and global share is about 60% in the anode binder market. The company already generates sales and earnings from HEV, plug-in EV, and other applications. Automakers have already reached tentative agreements to use its product for their vehicles. LiB binders for next-generation cars are the development stage, and sample shipments have been made.

JSR (4185.T, Buy)

JSR manufactures water binders with SBR bases and ranks alongside Zeon as a top maker of anode binders. Most binders are used in mobile devices, but we understand that sample shipments to domestic and overseas automakers started in 2009 on expectations of demand for use in automotive LiBs.

Kureha (4203.T, NR)

Kureha is the largest maker of cathode binders. Its share is reportedly around 70% in the cathode binder market and about 30% in the anode binder market. The company has decided to strengthen production facilities in order to satisfy growing demand for LiB binders and for PVDF used in engineering plastics for industrial applications. Production capacity is 2,700 tons annually, but the company plans to increase it to 4,000 tons by July 2011. LiB binders are expected to experience steady growth as demand for small LiBs for consumer electronics increases. Kureha expects surging demand for large LiBs used in cars, stationary power units for energy storage, and other applications.

Appendix 1

Important Disclosures

Additional information available upon request

Disclosure checklist

Company	Ticker	Recent price*	Disclosure
Toray Industries	3402.T	549 (JPY) 25 Jan 11	14
Asahi Kasei	3407.T	571 (JPY) 25 Jan 11	6
Mitsubishi Chem. Holdings	4188.T	591 (JPY) 25 Jan 11	8,17
Hitachi Chemical	4217.T	1777 (JPY) 25 Jan 11	NA

*Prices are sourced from local exchanges via Reuters, Bloomberg and other vendors. Data is sourced from Deutsche Bank and subject companies.

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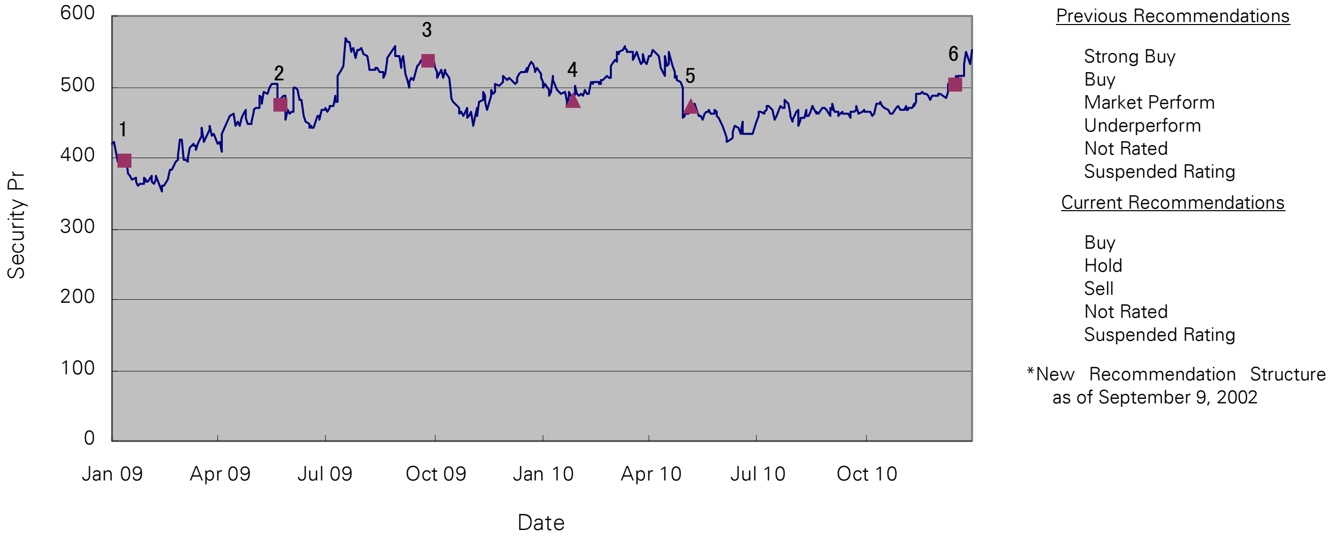
Historical recommendations and target price: Toray Industries (3402.T)

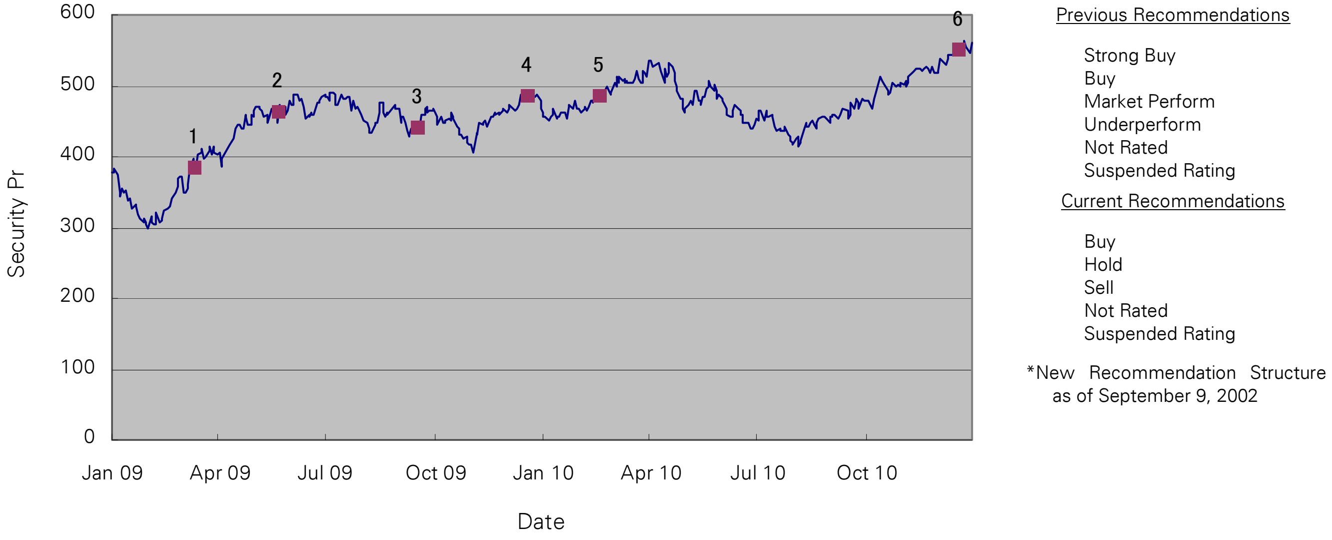
(as of 1/25/2011)



1.	7/2/2009:	Sell, Target Price Change JPY300	4.	22/2/2010:	Upgrade to Hold, Target Price Change JPY460
2.	18/6/2009:	Sell, Target Price Change JPY380	5.	1/6/2010:	Upgrade to Buy, Target Price Change JPY600
3.	21/10/2009:	Sell, Target Price Change JPY420	6.	11/1/2011:	Buy, Target Price Change JPY620

Historical recommendations and target price: Asahi Kasei (3407.T)

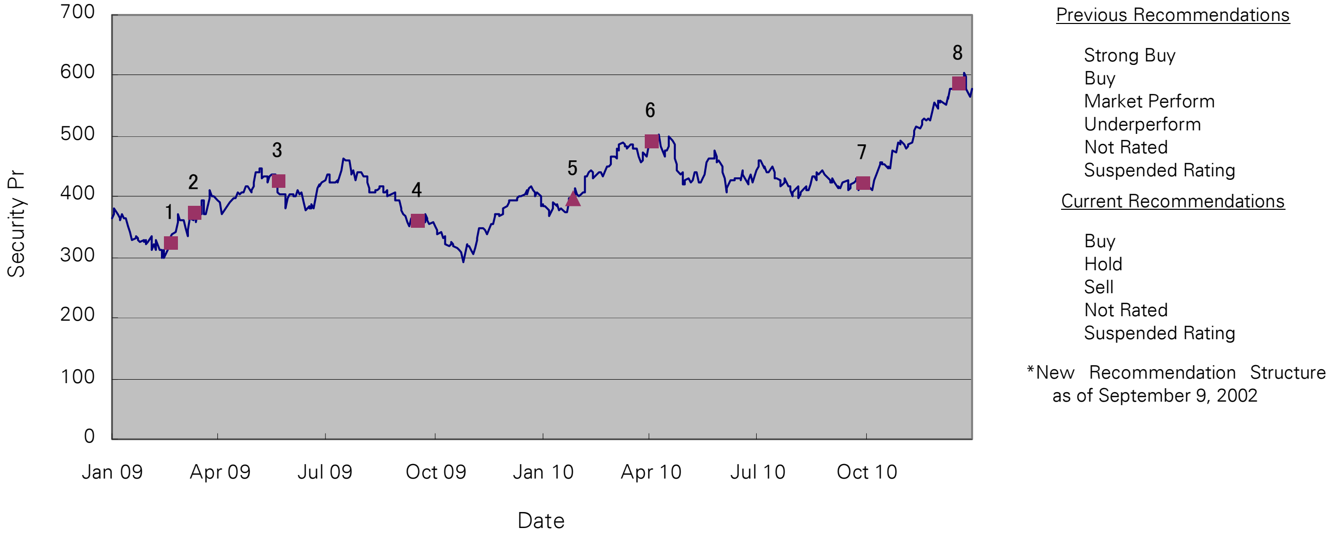
(as of 1/25/2011)



1.	7/4/2009:	Buy, Target Price Change JPY500	4.	13/1/2010:	Buy, Target Price Change JPY560
2.	16/6/2009:	Buy, Target Price Change JPY540	5.	15/3/2010:	Buy, Target Price Change JPY570
3.	13/10/2009:	Buy, Target Price Change JPY550	6.	14/1/2011:	Buy, Target Price Change JPY630

Historical recommendations and target price: Mitsubishi Chem. Holdings (4188.T)

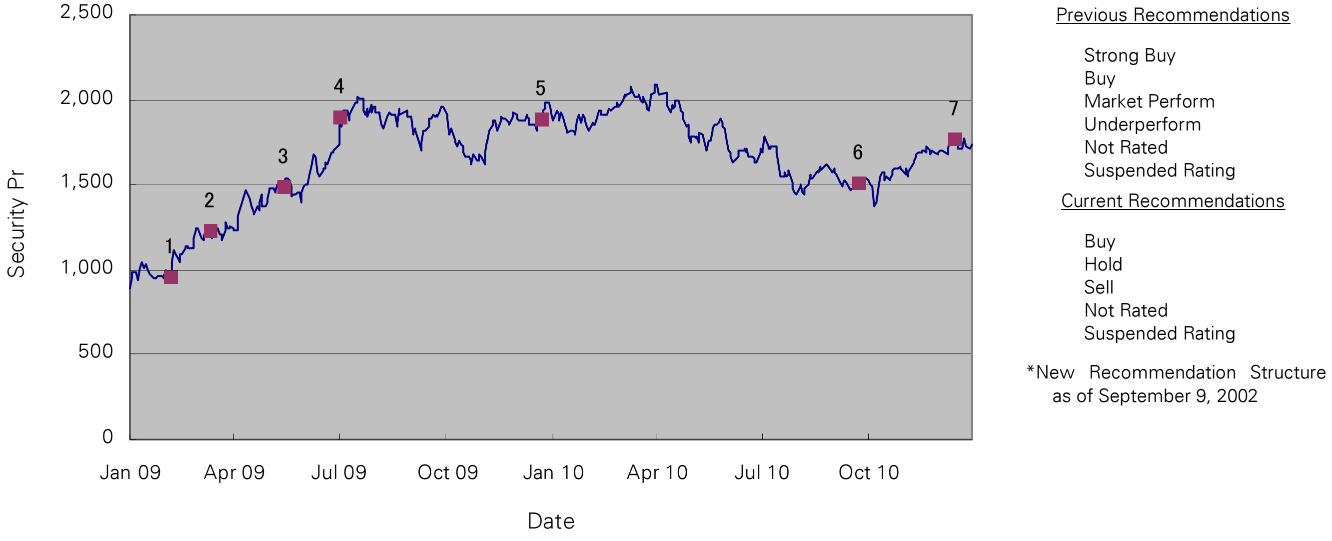
(as of 1/25/2011)



1.	17/3/2009:	Hold, Target Price Change JPY350	5.	22/2/2010:	Upgrade to Buy, Target Price Change JPY560
2.	7/4/2009:	Hold, Target Price Change JPY380	6.	28/4/2010:	Buy, Target Price Change JPY600
3.	16/6/2009:	Hold, Target Price Change JPY460	7.	25/10/2010:	Buy, Target Price Change JPY700
4.	13/10/2009:	Hold, Target Price Change JPY430	8.	14/1/2011:	Buy, Target Price Change JPY800

Historical recommendations and target price: Hitachi Chemical (4217.T)

(as of 1/25/2011)



1.	3/3/2009:	Buy, Target Price Change JPY1,200	5.	18/1/2010:	Buy, Target Price Change JPY2,500
2.	7/4/2009:	Buy, Target Price Change JPY1,400	6.	20/10/2010:	Buy, Target Price Change JPY2,300
3.	10/6/2009:	Buy, Target Price Change JPY1,700	7.	10/1/2011:	Buy, Target Price Change JPY2,100
4.	28/7/2009:	Buy, Target Price Change JPY2,300			

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Buy: Based on a current 12- month view of total shareholder return (TSR = percentage change in share price from current price to projected target price plus projected dividend yield) , we recommend that investors buy the stock.
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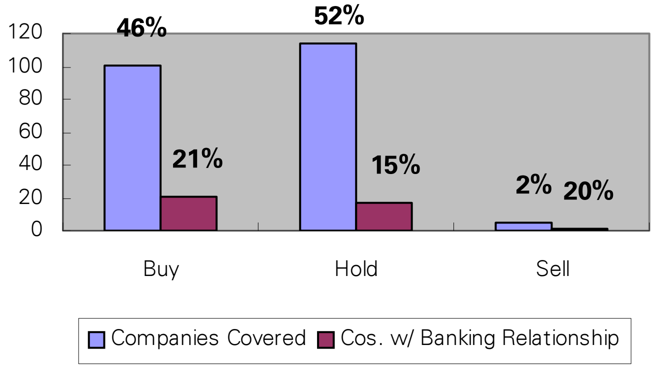
   - Sell: Expected total return (including dividends) of -10% or worse over a 12-month period

Equity rating dispersion and banking relationships



Japan Universe

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