DOI: 10.1595/147106707X205857



# Why Use Platinum in Catalytic Converters?

Why is platinum used over other catalytic materials such as silver or gold?

The role of platinum in catalytic converters is to oxidise carbon monoxide (CO) and hydrocarbons. Platinum is particularly effective at this under oxygen-excessive conditions, so is often the metal of choice for diesel applications. For petrol-powered vehicles (where there is a balance between reductants and oxidants in the exhaust gas), platinum and palladium can be equally effective, and so the choice is often made on the basis of relative cost. The three-way catalyst used for petrol vehicles must also be able to reduce NOx to nitrogen as well as oxidise CO and hydrocarbons – that is why rhodium is generally used in addition to platinum or palladium.

Of course, some of the other transition elements are also capable of catalysing oxidation reactions. However, platinum has several advantages:

- it has a high melting point;
- its interactions with 'poisons' (such as sulfur compounds) are limited to the metal surface;
- it can be efficiently recycled.

Although its high melting point may seem irrelevant, because the platinum will never come close to that temperature during use, it does provide an indication of its overall thermal durability. In a catalytic converter, the metal is in the form of nanoparticles, which are dispersed over the entire surface of a highly porous support material. As the temperature of the catalyst rises, the particles start to become mobile and can coalesce – this is called *sintering*, and becomes particularly noticeable as the metal approaches its Tammann temperature, at which bulk mobility of the metal particles becomes measurable. This temperature is often taken to be half the material's melting point on the absolute temperature scale (1). Metals such as gold and silver have a Tammann temperature (see Table I) that is well below the average exhaust-gas temperature (600–700°C) for a petrol car being driven on a motorway, and so this precludes their use in three-way catalysts.

Table I

The Platinum Group Metals and Their Nearest Neighbours, Showing Atomic Number, Chemical Symbol and Tammann Temperature (°C)

| | | | | |
|---|---|---|---|---|
| 25 **Mn** 485°C | 26 **Fe** 630°C | 27 **Co** 610°C | 28 **Ni** 590°C | 29 **Cu** 405°C |
| 43 **Tc** 975°C | 44 **Ru** 990°C | 45 **Rh** 845°C | 46 **Pd** 640°C | 47 **Ag** 345°C |
| 75 **Re** 1450°C | 76 **Os** 1375°C | 77 **Ir** 1085°C | 78 **Pt** 750°C | 79 **Au** 395°C |

In addition, metals such as silver and copper have a high affinity for sulfur-containing molecules, with which they will react to form compounds (such as metal sulfates or sulfides). As this happens, there will be progressively less metal available for the useful reactions to take place. Platinum is different because it tends not to become totally or irreversibly poisoned, i.e. sulfur-containing molecules inhibit rather than poison platinum-based catalysts (see also (2)).

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## References

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