

catalytic converter

an air pollution control device

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Air Pollution

Air pollution is one of the biggest threats for the environment and affects everyone: humans, animals, crops, cities, forests, aquatic ecosystems...

How to improve air quality?

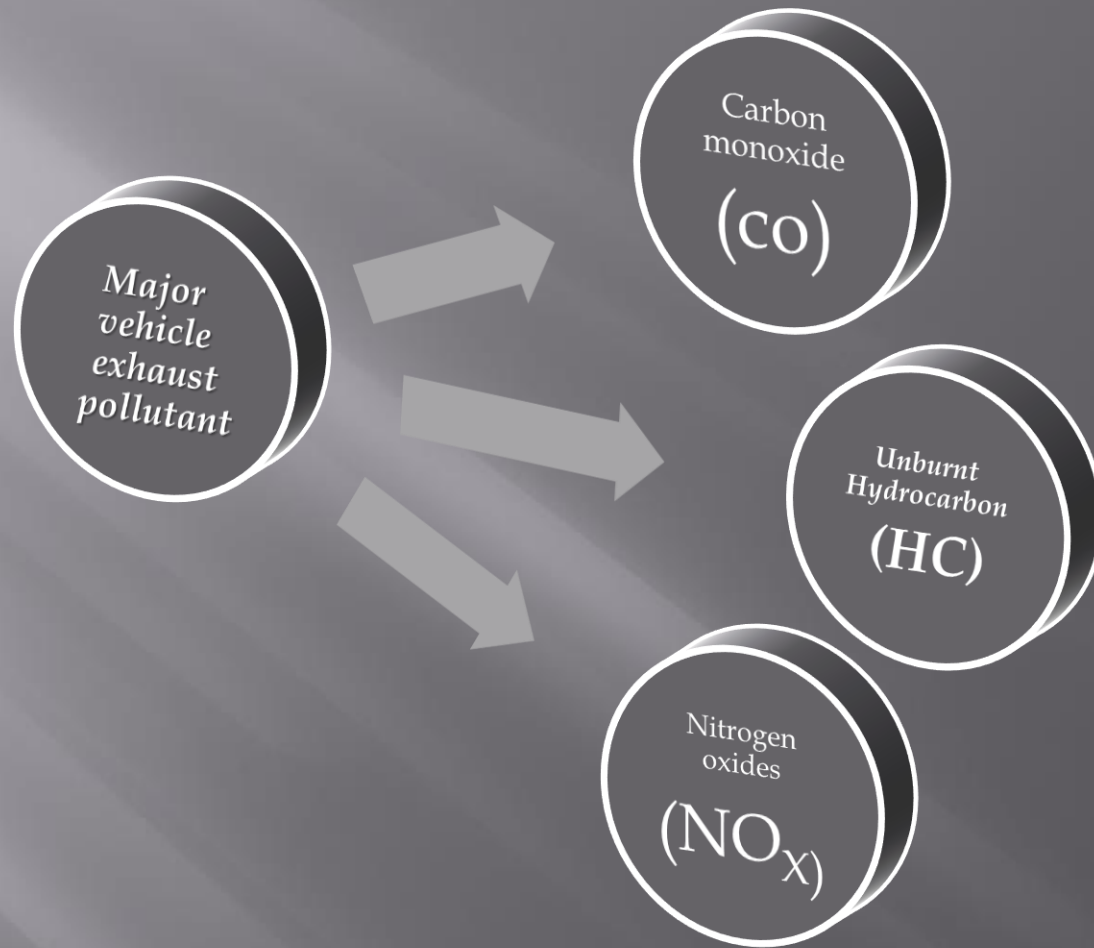
Find out the causes, effects and solutions to air pollution, and how you can contribute to prevent, control and reduce it

Sources

- natural*
- anthropogenic*

Automobile plays an imp role in contribution to the pollution

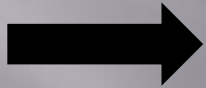




The emissions exhausted into the surroundings pollute the atmosphere and cause global warming, acid rain, smog, odors, and respiratory and other health hazards.

Brief History of the Catalytic Converter

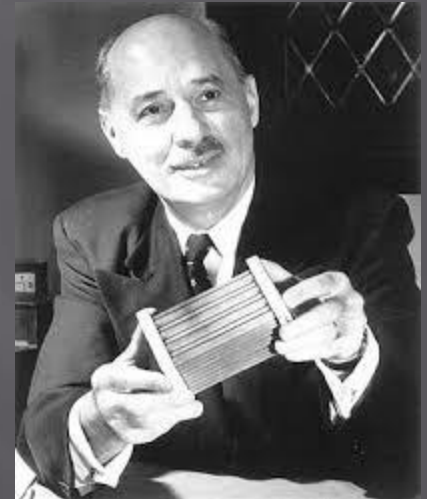
*Environmental, ecological and health concern resulted in stringent emission regulations for pollution control by vehicles
Among all the types of technologies developed so far, use of catalytic converters is the best way to control auto exhaust emission*



1909 AECC

The catalytic converter was first invented by Eugene Houdry in the 1960's.

He built a generic catalytic converter capable of reducing carbon monoxide and unburned hydrocarbons from automobile exhausts



MEASURES TAKEN TO CONTROL AIR POLLUTION

Clean Air Act (CAA), U.S. federal law, passed in 1970 and later amended, to prevent air pollution

| | 1975 | 1981 | 1993 | 2004 | 2007 |
|--------------------------|------|------|------|-------|-------|
| HC(g/mile) | 1.5 | 0.41 | 0.25 | 0.125 | 0.075 |
| CO(g/mile) | 15 | 3.4 | 3.4 | 1.7 | 3.4 |
| NO _x (g/mile) | 3.1 | 1.0 | 0.4 | 0.2 | 0.05 |

As the emission standards were tightened, more advanced control strategies were applied

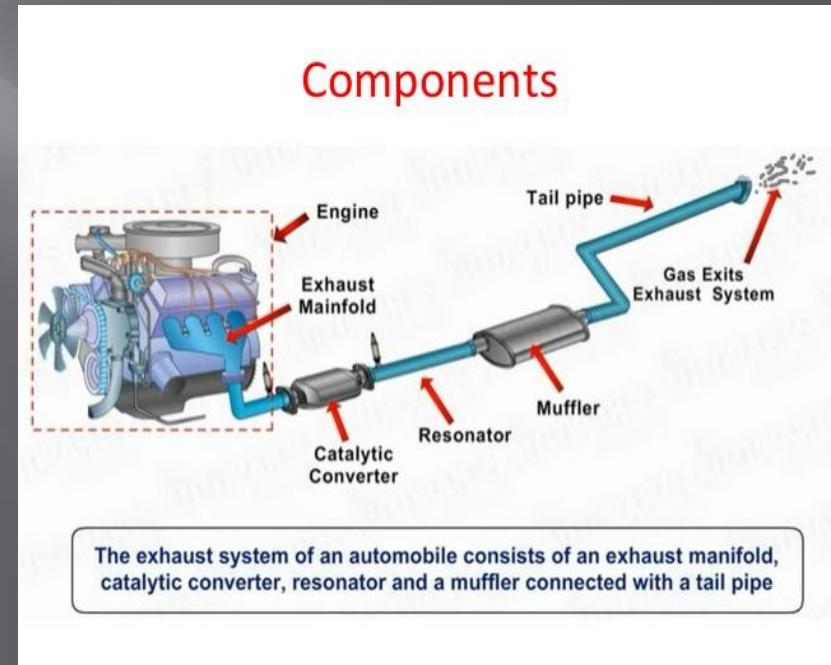
In a major effort to following passage of the Clean Air, car makers have developed an interesting device called a catalytic converter

Catalytic converter

A “catalytic converter” is a device used to reduce the toxicity of emissions from an internal combustion engine. A catalytic converter converts the harmful toxic combustion products and its by products into less-toxic substances

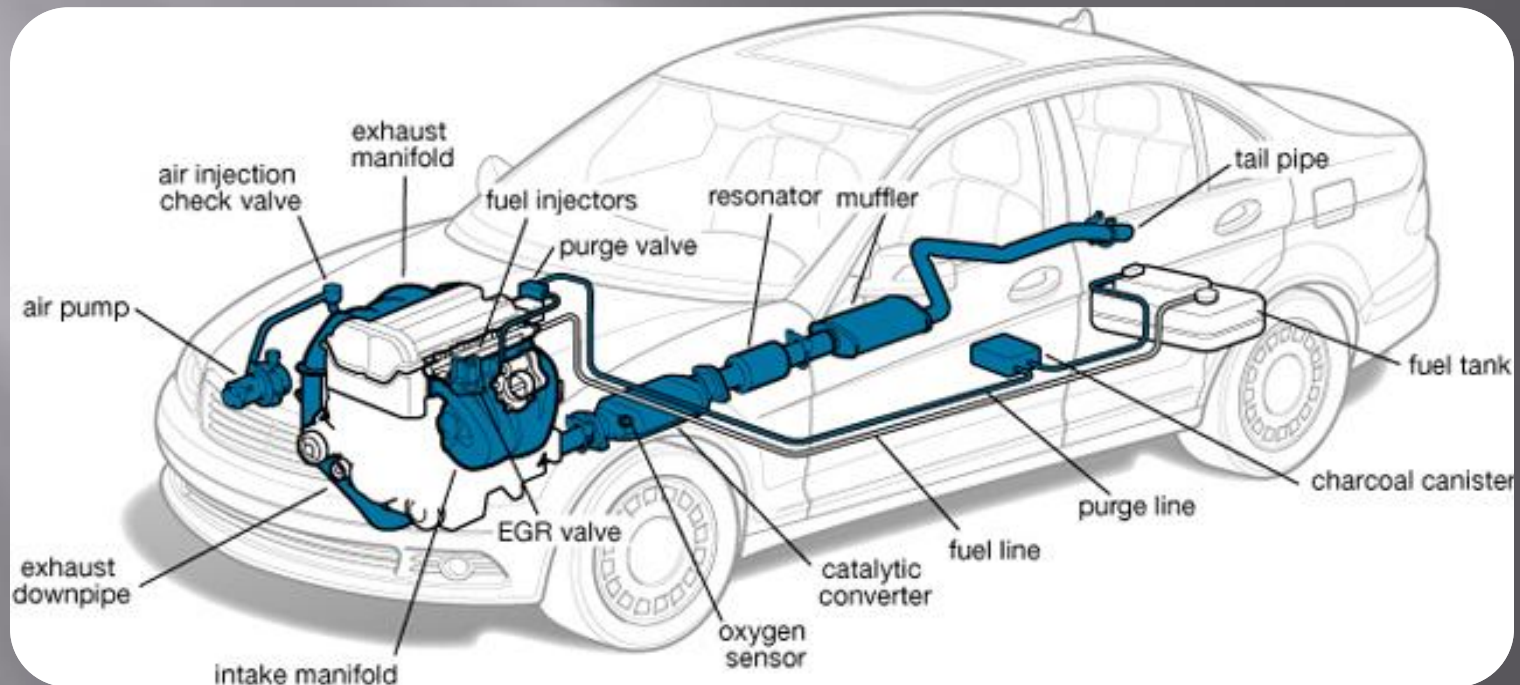
Exhaust System

An exhaust system is usually piping used to guide reaction exhaust gases away from a controlled combustion inside an engine. The entire system conveys burnt gases from the engine and includes one or more exhaust pipes.



catalytic converter location

This device is installed in the exhaust system between the exhaust manifold and the muffler, and usually is positioned beneath the passenger compartment.



Types of Catalytic Converters

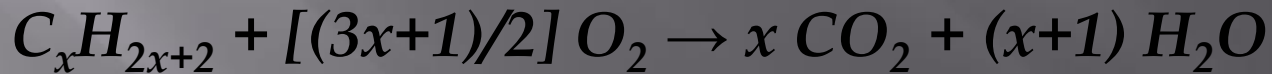
two way catalytic converter

catalytic converter has two tasks:

➔ *Oxidation of carbon monoxide to carbon dioxide*



➔ *Oxidation of unburnt hydrocarbons and particulate matter to carbon dioxide and water*

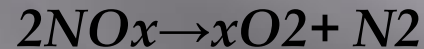


But! How to Control NO_x

THREE-WAY CATALYTIC CONVERTER

TWC has three simultaneous tasks:

➔ *Reduction of nitrogen oxides to nitrogen and oxygen*



➔ *Oxidation of carbon monoxide to carbon dioxide*



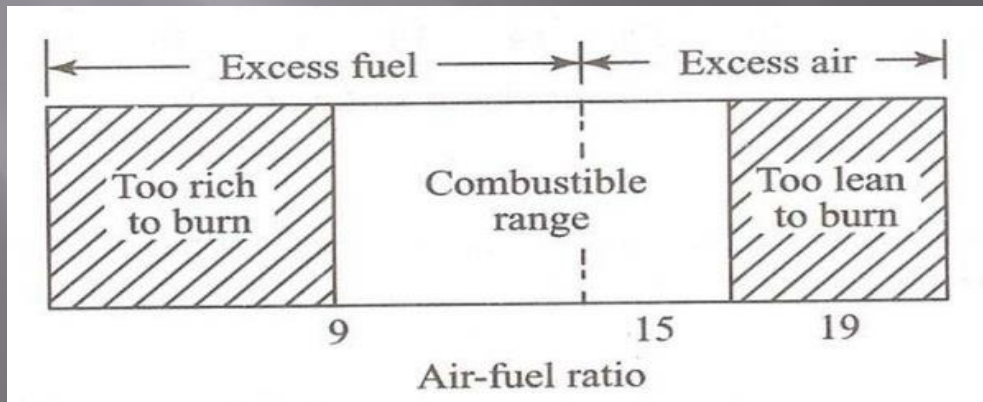
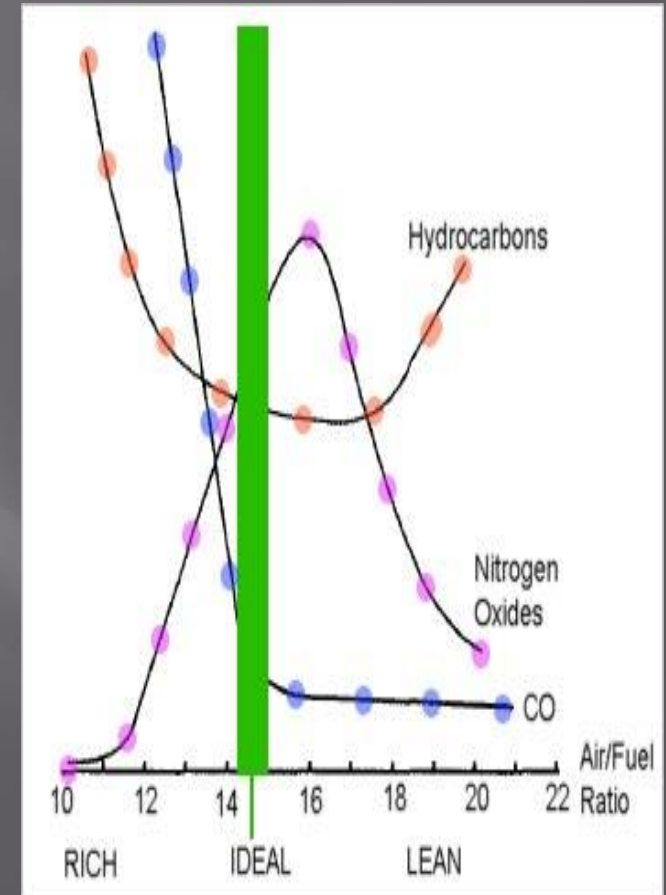
➔ *Oxidation of unburnt hydrocarbons to carbon dioxide and water*



catalytic converter efficiency

These three reactions occur most efficiently when when the air-fuel mixture is about 14.7

$$\lambda = \frac{\left(\frac{\text{Air}}{\text{Fuel}}\right)_{\text{actual}}}{\left(\frac{\text{Air}}{\text{Fuel}}\right)_{\text{stoichiometric}}}$$



CONSTRUCTION OF A CATALYTIC CONVERTER

1. The Core or Substrate

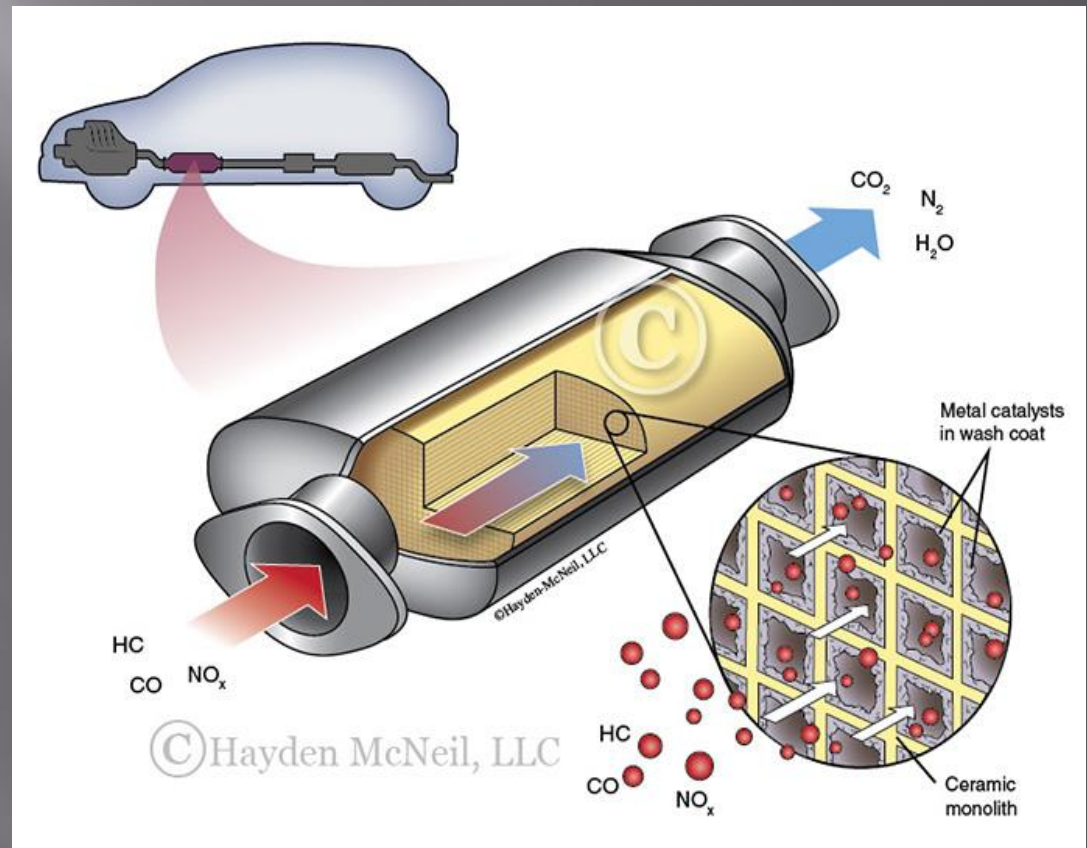
- Metal-core converter
- Ceramic-core converter

2. The Washcoat

3. The Catalyst

Mat Insulator

metallic casing



How a catalytic converter works?

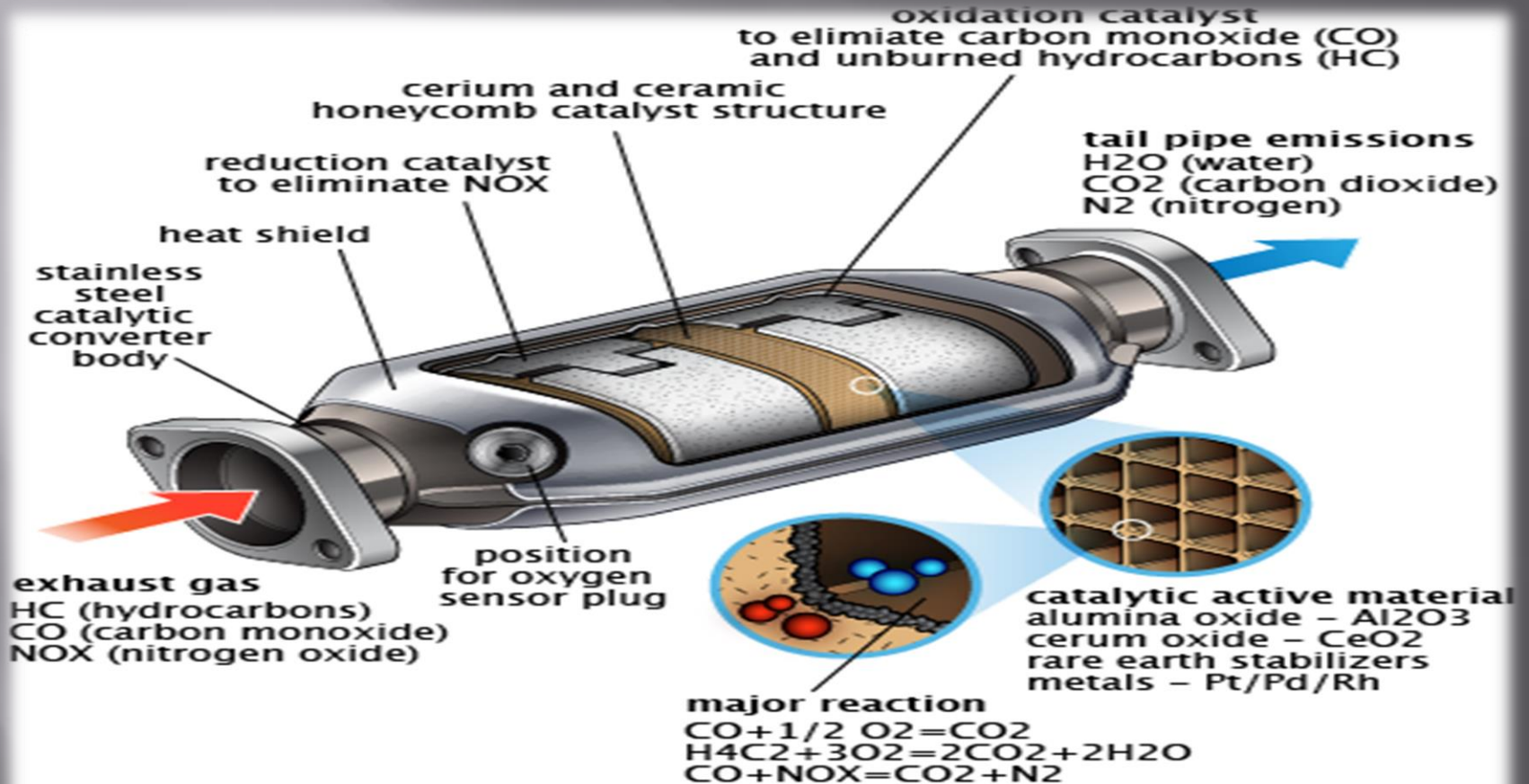


Image courtesy of ClearMechanic.com

DAMAGE TO CATALYTIC CONVERTERS

The three main causes of premature converter failure are as follows:

-Contamination

Catalyst poisoning occurs when the catalytic converter is exposed to exhaust containing substances that coat the working surfaces, encapsulating the catalyst so that it cannot contact and treat the exhaust

-Excessive temperatures

Excessively high exhaust temperatures burned this catalytic converter to a crisp

-physical damage



What are the symptoms of a bad catalytic converter?

Here are five signs that something may be wrong with your catalytic converter:

- 1. Your vehicle's fuel efficiency suddenly drops.*
- 2. Loss of power when accelerating*
- 3. Your vehicle may refuse to start.*
- 4. Your vehicle fails an emissions test.*
- 5. The MIL or Check Engine light comes on.*

LIMITATION OF CATALYTIC CONVERTER

*affect engine performance
and cause a reduction in
power and acceleration*

*High temperatures may
affect all the components
of the catalyst*



*have an
excessively long
warm-up time
period*

*PGMs are
extremely
expensive and
rare*

*Cannot function well
beyond 80000 km*

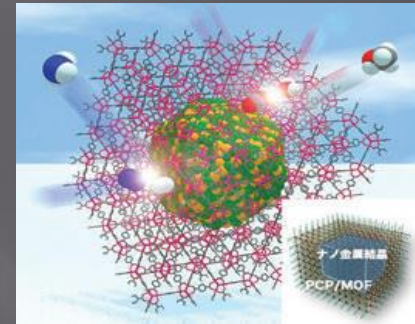
recent studies

- Because of economical reasons, limited resources of platinum group metal and some operating limitations of platinum group metal based catalytic converters researchers have motivated the investigation of alternative catalyst materials*
- Office Of Society Academia Collaboration For Innovation (SACI)*

In the future

Catalytic converters will be:

- smaller*
- lighter*
- more efficient*
- capable of nano particle removal*
- required until hydrogen fuel becomes widely available*



Mazda unveils plans to cut precious metal use by using nanoparticles

Mazda Motor Corporation has unveiled a new generation of catalytic converters that use 70 to 90 per cent less of the precious metals which help to purify exhaust emissions.

The converters rely on nanoparticles of the catalytic metal, each less than five nanometres across, studded onto the surface of tiny ceramic spheres. The Japanese firm claims this is the first time 'a catalyst material has been achieved that features single, nanosized precious metal particles embedded in fixed positions.'



Thank you for your attention!