# *Novel plasma catalysts significantly reduce $NO_x$ from diesel engines*

OAAT ACCOMPLISHMENTS

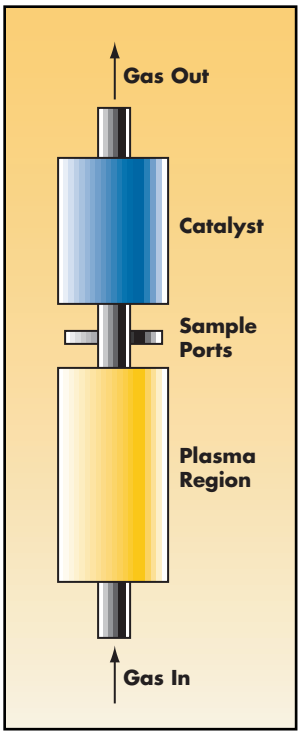
## Plasma-Assisted Catalyst Systems

## Challenge

Advanced exhaust aftertreatment technologies are being explored to significantly reduce oxides of nitrogen ($NO_x$) and particulate emissions from diesel engines. One such technology – plasma-assisted catalyst systems – can lower $NO_x$ emissions by 70% from simulated diesel exhaust. However, these systems must be demonstrated on real diesel engine exhaust over a broad range of exhaust temperatures. The goal is to achieve 90% $NO_x$ reduction using less than 5% of engine power on a compression ignition direct injection (CIDI) engine. The program supports goals of the Partnership for a New Generation of Vehicles (PNGV).

## Technology Description

New plasma catalysts have been discovered that reduce $NO_x$ over a wider temperature window when placed in or downstream from a plasma reactor. Improvements in the efficiency and design of the plasma reactor systems, as well as in the efficiency of the catalysts, are necessary for successful vehicle applications. Research in FY00 focused on 1) evaluating plasma catalyst prototype systems on real engine exhaust, 2) improving catalyst and reactor efficiencies, and 3) revealing mechanisms that lead to $NO_x$ reduction using select catalysts.




*Prototype plasma catalyst system.*

## Accomplishments

Two promising catalysts were combined in optimal proportions to achieve $NO_x$ reductions of at least 65% over a broad range of temperatures (150-400° C) typical of diesel exhaust. Simultaneously, particulate matter (PM) emissions were reduced by 92-96%, and formaldehyde emissions (a source of vehicle air toxics) by over 40%.

A prototype double dielectric barrier plasma reactor was tested in a production 1996 1.9L Volkswagen TDI diesel engine. Current certification diesel fuel with a sulfur level of 350 ppm (over 10 times that of regulated diesel fuel sulfur levels due to go into effect in 2007) was used for the engine testing. Under typical exhaust gas recirculation conditions, the prototype was able to achieve between 20 and 57% $NO_x$ reduction. The reactor consumed 2.7% of available engine-out power (0.6 hp).

$NO_x$ reduction depends upon available hydrocarbon (HC) to react with and to reduce $NO_x$ emissions to benign $N_2$, elemental nitrogen gas. However, not enough HC exits in the engine exhaust to support this reaction; additional HC must be added. Work on the prototype reactor confirmed that the optimal ratio of HC to $NO_x$ is 6:1.

## Contacts

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## Benefits

This work makes progress toward the U.S. Environmental Protection Agency's (EPA) goal to reduce diesel $NO_x$ emissions by 90%. Simultaneously, plasma-assisted catalysts reduce PM emissions and formaldehyde emissions, which the EPA has identified as a source of vehicle air toxics.

Plasma-assisted catalysts can achieve effective $NO_x$ reductions with only a limited demand on engine power.

## Commercialization

In a step toward commercialization, a prototype double dielectric barrier reactor was developed and tested on a production diesel engine. The efficiency of $NO_x$, PM, and formaldehyde removal was measured. The optimum amount of hydrocarbon necessary to promote the plasma catalytic reduction of $NO_x$ was assessed as well.

## Future Activities

This project will continue to develop higher activity (greater $NO_x$ reduction) catalysts that are durable over long periods of time in a real diesel environment. Mechanisms of $NO_x$ reduction over catalyst surfaces will be investigated to illuminate ways to optimize both $NO_x$ and PM removal efficiency.

Improved prototype plasma reactor systems will be developed for testing on production engines in late 2001.

Research will continue to probe mechanisms of $NO_x$ reduction over catalyst surfaces.

The project will investigate ways to optimize both the $NO_x$ and particulate removal efficiency of plasma catalyst systems.

## Partners in Success

- DaimlerChrysler Corporation
- Ford Motor Company
- General Motors Corporation
- Oak Ridge National Laboratory
- Pacific Northwest National Laboratory