# A laser shines light on the catalytic converter

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(PhysOrg.com) -- Catalytic converters are encountered everywhere in our cars and in the chemical industry. However, the chemical reaction is not well understood. A discovery made at the EPFL may help to shed light on a field with high economic and ecological stakes.

Universally present in industry, the chemical phenomenon of catalysis is surprisingly poorly understood. Production of plastics, conversion of natural gas into hydrogen and even the synthesis of margarine... These are just a few examples of processes which require the use of a catalytic converter. However, the application which is best known to the general public remains the catalytic converter in the exhaust pipes fitted on our motor vehicles. Researchers from the EPFL have published an article in *Science* describing a discovery which should help to achieve a better understanding of the process. This study could pave the way for new techniques which ensure better performance and are less costly.

One of the most frequently used types of catalysis involves a gas and a solid - this is known as "heterogeneous catalysis". For example, in the catalytic converters fitted in the exhaust pipes of our vehicles, the harmful emanations are converted on contact with a platinum or palladium surface. The process itself is well-known, but the molecular mechanism remains obscure.

## A laser makes it 10,000 times faster

Researchers at the EPFL studied heterogeneous catalysis. Methane mixed with water vapour is converted into hydrogen and CO on contact

with a nickel surface. Using a powerful laser, chemists have been able to excite the vibrations and to orientate the methane molecules - by a procedure which is rather like using a joystick. Surprisingly enough, this process increases the effectiveness of the reaction many times over. "The improvement is impressive", in the words of Rainer Beck, who is in charge of the project at the EPFL. "The use of a laser speeds up the process by a factor of between 1000 and 10,000!"

This observation conflicts with the theory which is commonly used to describe the process. The generally held view in fact is that the reaction can only be speeded up by increasing the energy - i.e. the heat - of the gas. The new discovery shows that our understanding of the phenomenon is rather limited, according to Rainer Beck. “In order to find a good catalytic converters, trial and error methods are used rather than design because a detailed understanding of how they work is often missing.”

## Environmental and industrial stakes

Conversion of methane is of great environmental interest. This gas which is used massively as a fuel, and burning methane releases a substantial quantity of CO2. “We might imagine its conversion on the capture sites which would then enable to capture CO2 at source and use hydrogen instead as the fuel, which burns cleanly producing only water as exhaust”. Although the process developed at the EPFL cannot be used on an industrial scale, Rainer Beck's work does hold out the prospect of future improvements.

The interest of the discovery does not stop there. A substantial number of catalyses might also be concerned. In the chemical industry, over 90% of all processes involve catalysis at one time or another. Rainer Beck returns to the example of motor vehicles: “At present, platinum or palladium which are rare and expensive metals are being used. By gaining a better understanding of what is involved, we might be able to

find a solution which permits the use of less expensive materials".

**More information:** Science paper: www.sciencemag.org/cgi/content … ull/sci;329/5991/553

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