The dance of the atoms

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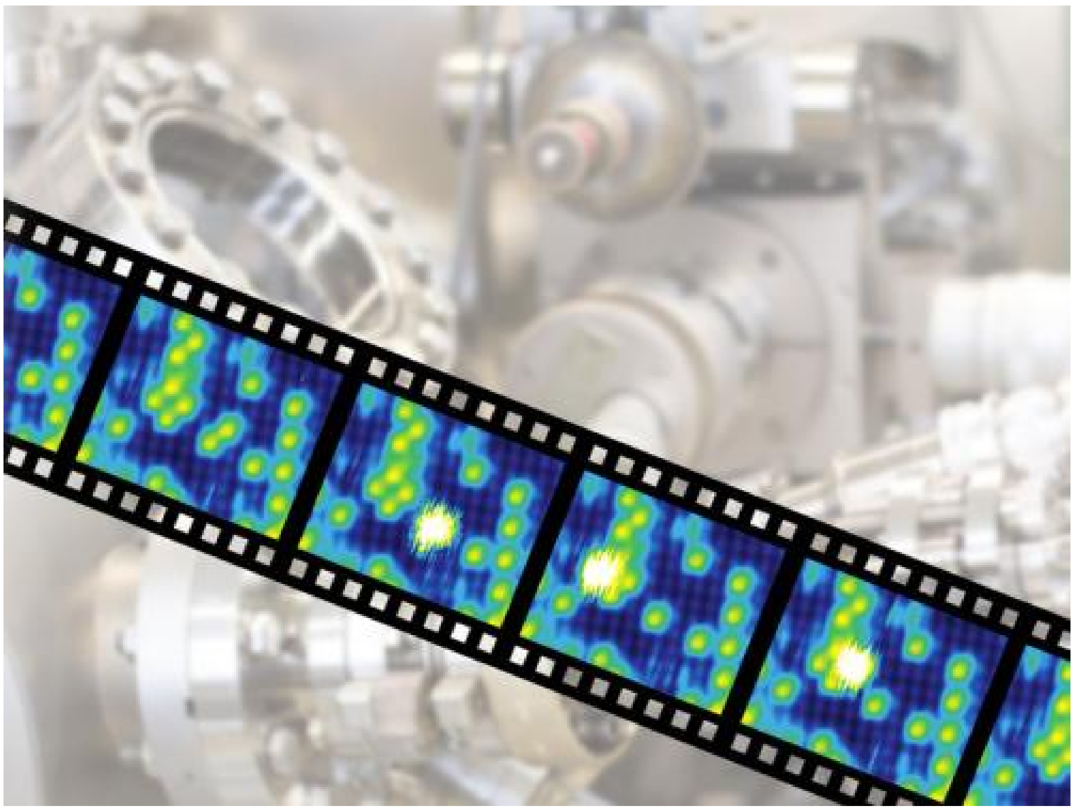


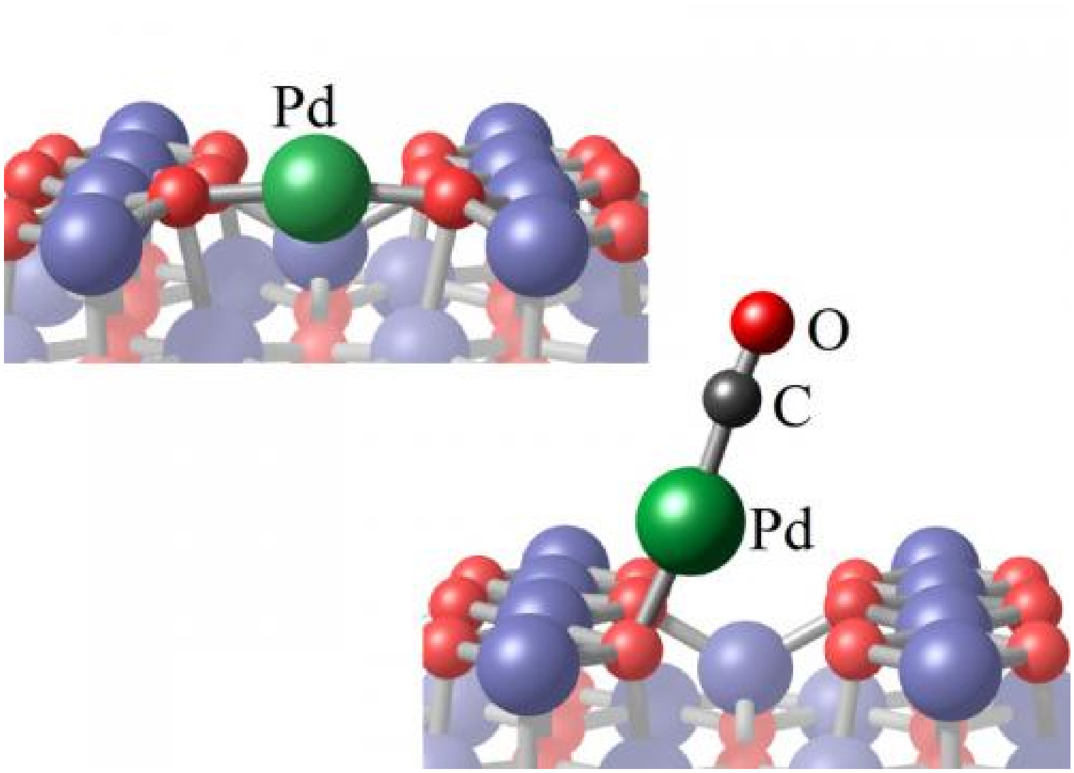
Single Pd atoms are visible on the surface.

(Phys.org) —Catalysts can stop working when atoms on the surface start moving. At the Vienna University of Technology, this dance of the atoms could now be observed and explained.

Lone people standing in a ballroom don't tend to move a lot. It's only when they find a suitable dance partner that rapid motion sets in. Atoms on iron-oxide surfaces behave in a similar way: Only with the right molecular partner do they dance across the surface. Scientists at the Vienna University of Technology have now filmed the atoms, proving that carbon monoxide is the partner responsible for the quick motion. Their movies show that the motion leads directly to clustering – an effect that can do great harm in catalysts. The findings have now been published in the journal *Nature Materials*.

Clusters – What a waste of atoms!

"Metals such as gold or palladium are often used as catalysts to speed up certain chemical reactions", says Professor Ulrike Diebold (Institute of Applied Physics, Vienna University of Technology). When the atoms ball together, most of them do not get into contact with the surrounding gas any more and the catalytic effect diminishes drastically. For this reason, Ulrike Diebold's team investigates how clusters form from single atoms on a surface, and search for ways to inhibit the process.



The Pd atom on the surface (top) is lifted up by the CO-molecule, allowing it to diffuse.

Theories about this effect have been discussed for years, but the researchers at the Vienna University of Technology have now directly observed the clustering of the atoms. "We are using palladium atoms on an extremely clean iron-oxide surfaces in an ultra high vacuum chamber. For several hours, we take pictures of the surface with a scanning tunneling microscope", says Gareth Parkinson (Vienna University of Technology). These pictures were then made into a movie, in which the paths of the individual atoms could be tracked.

The skyhook effect

Using this technique, the research team discovered that the rapid atomic dance on the surface is initiated by carbon monoxide molecules, which bind to individual palladium atoms. As soon as this happens, the palladium is hardly connected to the ground and can move around almost freely, as if it had been lifted out by the carbon monoxide. "This is known as the skyhook effect", says Zbynek Novotny (Vienna University of Technology).The carbon monoxide and palladium move happily together across the surface, until they collide with other 'dancing couples'. Then, they stick together creating a small cluster that continues to grow.

Hydroxyl against clustering?

With the new possibility of watching clustering in real-time under the microscope, the mechanisms can now be studied in detail: "We discovered that OH groups on the surface can suppress the clustering effect", says Gareth Parkinson. If the carbon monoxide-palladium couples do not encounter each other, but instead find an OH group, they get trapped there and cannot form a cluster. A hydroxyl coating of the surface could therefore lead to a significant improvement of the stability of catalysts.

More information: www.nature.com/nmat/journal/va … t/full/nmat3667.html

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