Time scale established for proton transfer

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"In the past," Masanari Nagasaka tells *PhysOrg.com*, "we only knew that proton transfer was a fast process. Now we are able to determine the speed of proton transfer. This is a step in understanding the mechanism of proton transfer, which is very important in many fields."

Nagasaka is an assistant professor at the Institute for Molecular Science in Okazaki, Japan, and has belonged to the University of Tokyo, where until last year he worked as a doctoral student with Kondoh, Amemiya, Ohta and Iwasawa. Their work focuses on establishing the time scale of proton transfer between water (H_2O) and hydroxyl (OH) on a platinum (Pt) surface. Their work appears in *Physical Review Letters*: "Proton Transfer in a Two-Dimensional Hydrogen-Bonding Network: Water and Hydroxyl on a Pt(111) Surface."

"This is a two-dimensional bonding network," Nagasaka explains. "It becomes a model system to study proton speed, and to give us a time scale."

In the experiment, the team used laser-induced thermal desorption in order to prepare a specially patterned honeycomb arrangement of H2O and OH. Laser-induced thermal desorption is a method that allows for physical separation, usually from solids. A laser is used to provide heat in such a way as to prepare the special arrangement of the water and hydroxyl on the platinum surface.

At the same time, the evolution of the H_2O and OH distribution was observed with the help of microscale x-ray photoelectron sprectroscopy (micro-XPS). This process is used to measure elemental composition on a tiny scale, allowing the team in Japan to record the process. After analyzing the results, a diffusion equation was used to determine that direct proton transfer had taken place.

“This is very basic science,” Nagasaka explains. “Proton transfer is very important in physics, chemistry and even biology. But we don’t have a very good understanding of how the mechanism works. This is an important result, and a first step in studying how to control different reactions.”

Nagasaka says that it has been difficult to determine reaction rates, and this can impact different experiments in a variety fields, especially those that concern surface materials. “We were able to determine the speed on the nano time scale using our new method,” he points out. “This is first result like this, and there is a possibility to apply it to other processes.” He’s not sure, but he thinks that maybe the method of combining laser-induced thermal desorption with micro-XPS could be used to help study reaction rates in fusion.

Most of Nagasaka’s work focuses on surface chemistry – the study of how different molecules and atoms react on surfaces. The field of surface chemistry has grown in recent years to encompass electronics, fuel production (including renewable fuels) and other applications, such as artificial fertilizers. Understanding proton transfer could open up new avenues of study and lead to innovation in a number of fields, as well as in various scientific disciplines.

“This is really a model system,” Nagasaka explains. “During the next five years we will do further study.”