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Technique pinpoints active sites on catalyst surfaces

Scanning microscopy detects activity with unprecedented resolution while reactions occur

By ***Stu Borman***

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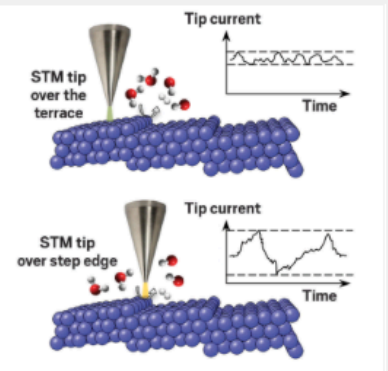

An STM instrument measures higher electron-tunneling signal noise at step edges (yellow) than on plateaus (green) of a terraced Pt surface (blue) as it catalyzes water splitting (red = oxygen, white = hydrogen).

Credit: *Nature*

Many industrial processes use solid catalysts to accelerate chemical reactions in gases or liquids. The activity of these heterogeneous catalysts often varies considerably from site to site across their surfaces. If scientists were able to identify highly reactive sites precisely, they could improve the catalysts by redesigning them to include more of those sites.

Aliaksandr S. Bandarenka and coworkers at the Technical University of Munich have now devised a scanning tunneling microscopy (STM) technique that identifies surface activity variations during reactions at higher spatial precision than has been possible before (*Nature* 2017, **DOI: 10.1038/nature23661**). Scanning electrochemical microscopy (SECM), which Allen J. Bard and coworkers at the University of Texas developed, can also map surface activity, but the new STM technique's 1- to 2-nm resolution is about an order of magnitude better than SECM's.

The ultimate goal is atomic resolution—still about two orders of magnitude away. But the new technique goes well beyond earlier approaches in its ability to identify site activity precisely, comments heterogeneous catalysis expert Alexis T. Bell of the University of California, Berkeley.

Bandarenka and coworkers used the technique to identify reactive sites on electrodes while the surfaces catalyzed hydrogen-evolution and oxygen-reduction reactions in solution. They found that catalytic activity is stronger at step edges than on plateaus of a terraced Pt surface.

What makes the technique work is that electron-tunneling current between an STM tip and a nearby surface spot varies considerably with reaction activity. As a reaction occurs, localized surface variations, such as molecular adsorption and desorption, cause noise changes in the electron-tunneling current. The researchers identify and measure activity differences by monitoring these changes.

Hans Niemantsverdriet, director of the catalysis and surface science firm Syngaschem, says the work "is truly remarkable and a significant step forward in making catalytic sites visible" and wonders if it can also be extended to gas-phase reactions, in which noise variations would be smaller.

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