The ability to produce thin, uniform dielectric regions within a conductive polymer film makes this maskless lithographic technique a particularly attractive route to flexible batteries, supercapacitors, or interdigitated electrodes. As a one-step process performed entirely in the solid state, it serves as a promising demonstration of the potentially low-cost large-scale methods available to organic electronics, said the researchers.

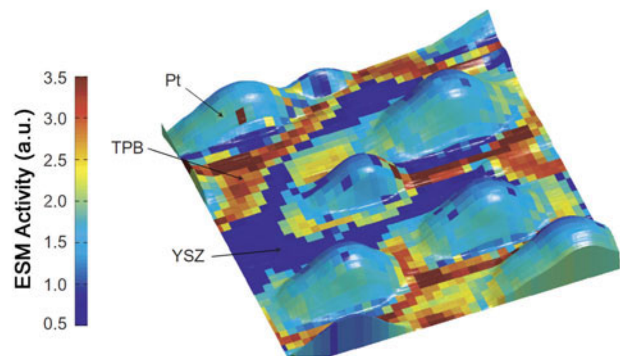
Tobias Lockwood

Energy Focus

SPM reveals nanoscale understanding of oxygen reactions in fuel cells and batteries

Researchers are currently exploring the use of atmospheric oxygen as an oxidizer in fuel cells and lithium-air batteries to improve energy-storage densities. However, its implementation is currently limited by a poor understanding of surface reaction kinetics. In the September issue of *Nature Chemistry* (DOI: 10.1038/NCHEM.1112; p. 707), a research team reports on the use of a novel scanning probe electrochemical strain mapping (ESM) technique that makes it possible to study volumes of material 10^6–10^8 times smaller than current microcontact methods.

As described by the research team—A. Kumar of Oak Ridge National Laboratory, F. Ciucci of Ruprecht-Karls-University in Heidelberg, A.N. Morozovska of the National Academy of Science of Ukraine, and their colleagues—a scanning probe tip is first brought into contact with a surface, and an electric-field bias is then applied across the tip-surface junction. When a strong enough field is applied, the oxygen atoms react through the generation and annihilation of vacancies. This results in a local structural distortion that can be measured down to 2–5 pm resolution. Additional sensitivity is attained by slowly varying field pulses and using differential detection to remove topographic cross-talk and tip-induced mechanical effects on the substrate.



Map of electrochemical activity is overlaid onto the topography of Pt catalyst dots deposited on a YSZ surface. TPB indicates a triple-phase boundary where the catalyst electrode is in contact with both the reactants and electrolyte. Reproduced with permission from *Nature Chem.* (DOI: 10.1038/NCHEM.1112; p. 707). © 2011 Macmillan Publishers Ltd.

The researchers have demonstrated several applications of this technique, including measurements of oxygen vacancy kinetics and spatially resolved mapping of local electrochemical activity in yttria-stabilized zirconia (YSZ). They also show that it is possible to study more complicated systems, such as a YSZ substrate coated with an array of Pt catalyst dots. As shown in the figure, the researchers are able to map the surface of the material and measure an enhanced ESM response near the edges of the dots.

The research team predicts that this technique can be applied to studies of many other air-based fuel-cell systems and metal-air batteries. The high resolution and sensitivity of the technique will make it possible to bridge models across different length scales and optimize the design of energy-storage systems.

Steven Spurgeon

MARK YOUR CALENDAR

Coming in 2012

2012 MRS Spring Meeting **April 9 – 13** San Francisco, California, USA
New Diamond and Nano Carbons Conference **May 20 – 24** San Juan, Puerto Rico
Electronic Materials Conference 2012 **June 20 – 22** Pennsylvania State University, Pennsylvania, USA
American Conference on Neutron Scattering **June 24 – 28** Georgetown University, Washington, D.C., USA
2nd Global Congress on Microwave Energy Applications **July 23 – 27** Long Beach, California, USA
XXI International Materials Research Congress **August 13 – 17** Cancun, Mexico
2012 MRS Fall Meeting **November 26 – 30** Boston, Massachusetts, USA