Discovery of Current Spike Phenomenon in Semiconductor Materials Leads to New Understanding of Nanoscale Plasticity

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Plasticity in certain semiconductor materials at the nanoscale is actually linked to phase transformation rather than dislocation nucleation, as previously thought. This is shown by the results of an international research team led by Professor Roman Nowak of the Nordic Hysitron Laboratory (NHL) at Helsinki University of Technology, just published in the *Nature Nanotechnology* journal in an article entitled “An electric current spike linked to nanoscale plasticity”.

Plasticity has always been associated with defect movement or initiation, but Nowak’s team has proved that plasticity can indeed start from non-dislocation processes, and that this phase transformation occurs in a stressed nano-volume, changing from one crystalline structure to another without affecting defect activity. The phenomenon, named the “Current Spike”, is clearly visible, and its explanation relies heavily on advanced physics.

“The implications of these findings are such that our understanding of material behavior in the nano-regime may just need to be revised once again. If this approach is further developed to encompass other sets of materials than the ones studied here, this new evidence will certainly lead to many advances in pressure-sensing and pressure-switching applications, just to name one of many potential benefactors of these newly-revealed discoveries,” Nowak says.

While certainly enlightening on their own, the NHL's recently-published findings represent the first critical steps towards addressing an intriguing larger issue: Under which conditions and at which length scales does combined mechanical-electrical coupling lead to similar effects? NHL will be leading the way and acting as a source of inspiration in this quest for understanding of the deformation of materials at nanoscale.

The main target of NHL is the mechanical characterization of advanced materials and nanostructures using the nanoindentation testing technique. An instrument developed by Hysitron, Inc. of Minneapolis, USA allows for a quantitative and concurrent measurement of the mechanical and electrical properties. These experiments are complemented by computational methods, with the aim of exploring nanometer-size contacts in the material and arrive at the final unique clarification.

The NHL's success stems from well-targeted and carefully-organised collaboration with the best experts in the field. Both the NHL's efficiency and effectiveness are demonstrated by the recent publication, which was only made possible by virtue of the synergistic combination of the expertise in atomistic calculations of Professor Nowak and two visiting researchers, together with sophisticated nano-experimentation by Hysitron, Inc, USA, and a top proficiency in the production of advanced semiconductors at the Tampere University of Technology.

More information: "An electric current spike linked to nanoscale plasticity", R. Nowak, D. Chrobak, and S.Nagao, NHL, D. Vodnick and M. Berg, Hysitron Inc., A. Tukiainen and M. Pessa, Tampere University of Technology. *Nature Nanotechnology*. on-line version: 22 March 2009 | doi:10.1038/nnano.2009.49, www.nature.com/nnano/journal/v …s/nnano.2009.49.html

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