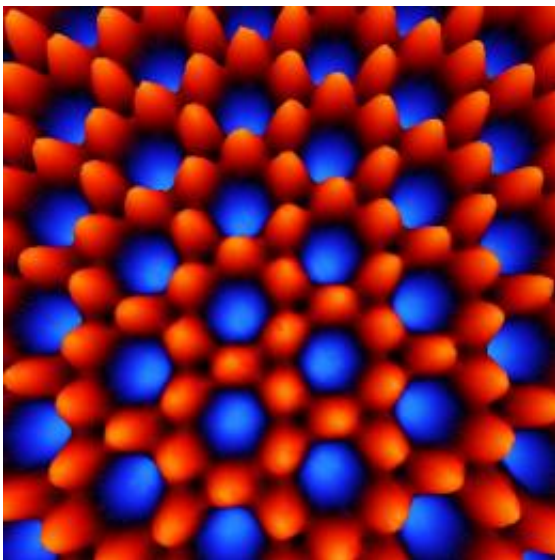


Controlling the electronic surface properties of a material

July 17 2009



A two-dimensional “electronic metamaterial” is generated by supramolecular selfassembly on a metal surface. The periodic influence of the porous molecular network on the otherwise free-electron-like surface state results in the formation of an electronic band.

A recent breakthrough by researchers at the Swiss Nanoscience Institute sees for the first time the creation of thin films with controllable electronic properties. This discovery could have a large impact on future applications in sensors and computing. The international collaboration of researchers from the Universities of Basel and Heidelberg and the Paul Scherrer Institute (Switzerland) have published the work in the prestigious scientific journal *Science*.

It's commonly accepted that electrical resistance of a given material cannot be adjusted as is the case with, for example, density and color. However, Dr Meike Stöhr and her collaborators have now succeeded in developing a new method to selectively tune surface properties such as resistance.

The interdisciplinary team of physicists and chemists have developed a substance which, after heating on a [copper](#) surface, exhibits a two dimensional network with nanometer sized pores. The interaction of this network with the existing electron gas on the metal surface leads to the following effect: the electrons underneath the network are pushed into the pores to form small bunches of electrons called [quantum dots](#).

By varying parameters such as the height and diameter of the pores the possibility arises to selectively tune the properties of the material. Further possibilities arise from the ability to fill the pores with different molecules. This allows direct access to the properties of the material which are dependent on the electronic structure, such as conductivity, reflectivity and surface catalysis properties. This will lead to the emergence of new materials with adjustable [electronic properties](#).

The underlying physical mechanisms can best be understood by a comparison of the electron-gas with waves in water. Waves on a water surface are reflected by any obstacle they meet. If the obstacle on the surface in question resembles a honeycomb structure, standing waves are set up in each cell of the honeycomb. This then leads to a wave pattern representative of the honeycomb structure of the same size and shape. “Applying this analogy to the electron gas, we see that the interaction of the network structure with the electron gas on the metal surface confines the electrons giving rise to a characteristic electron wave structure of the new material.” says Stöhr.

These pore networks are good candidates for new meta-materials. These

are man-made materials which, due to their period architecture, have specific optical and electronic properties not found in nature. These properties can be tuned by changing the properties of their component materials. In the case of pore networks, it is the electronic surface properties which can be tuned by careful selection of the nano-pores.

Source: Paul Scherrer Institut

Citation: Controlling the electronic surface properties of a material (2009, July 17) retrieved 10 April 2024 from <https://phys.org/news/2009-07-electronic-surface-properties-material.html>

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