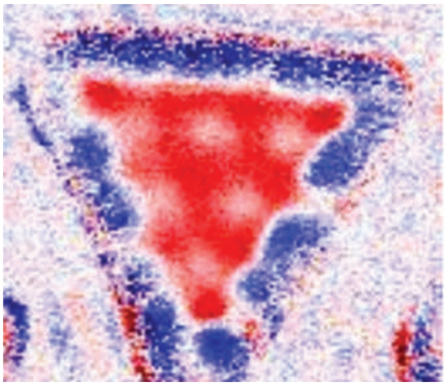
NANOMAGNETS

Spun patterns

Science **327,** 843–846 (2010)



The wave-like nature of matter leads to interference patterns similar to those on the surface of a pond. This was famously demonstrated in 1993 by Don Eigler and colleagues at IBM, who used a scanning tunnelling microscope (STM) to image the ripples of electrons confined inside a ring of iron atoms. Now, Valery Stepanyuk, Dirk Sander and colleagues at the Max Planck Institute of Microstructure Physics have imaged the spatial modulation of electron-spin polarization caused by electron interference patterns inside a single nanostructure.

Building on previous work, the researchers used a spin-polarized STM to probe a single triangular island of cobalt that was 12 nm long and supported on a copper substrate. The current flowing from the STM tip depended on its magnetic orientation relative to the part of the island just below it, and was used to construct a spatial map of polarization across the island. This map turned out to be a pattern of dots in the interior of the island, and a single rim state around its edge.

The pattern originated from the confinement of electrons inside the nanostructure, which led to spin-dependent interference patterns. This method may be applied to imaging spin polarization in other nanostructures. Furthermore, the interference patterns were shown to depend on the energy of the electrons, indicating a possible route to controlling polarization.

SURFACES

Pressure to change

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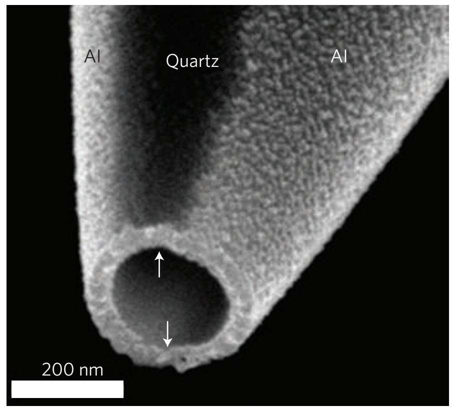
Industrial catalysts often have complex surface structures in which the active sites are under-coordinated surface atoms: species that have fewer nearest neighbours than other surface atoms. Stepped single-crystal surfaces — well-defined surfaces with atomically flat terraces connected by numerous atomic steps — have been used as model systems to study these catalysts, typically in ultrahigh vacuum environments. However, real catalysts must operate at pressures and temperatures much higher than these model experiments normally probe. Miquel Salmeron, Gabor Somorjai and colleagues at Lawrence Berkeley National Laboratory and the University of California, Berkeley have now examined stepped platinum surfaces under realistic reaction conditions and found that they undergo significant and reversible restructuring.

The researchers used scanning tunnelling microscopy and X-ray photoelectron spectroscopy to examine the adsorption of carbon monoxide (CO) — a reactant in many important commercial reactions — at near ambient pressures and at room temperature. As the CO surface coverage approached a complete monolayer, the platinum surfaces were found to break-up and form nanoscale clusters. When the CO was removed, the original surface structure returned. Density functional theory calculations indicate that the restructuring occurs to relieve CO–CO repulsion in the compressed high-coverage adsorbate layer.

MAGNETIC SENSORS

NanoSQUIDs get to the point

Nano Lett. doi: 10.1021/nl100009r (2010)



The best instrument for measuring a weak magnetic field is a superconducting quantum interference device (SQUID), and researchers have developed smaller and smaller versions of these devices in recent years. However, these nanoSQUIDs are usually planar, which makes it difficult to place them very close to the sample being probed. Now Amit Finkler and co-workers at the Weizmann Institute of Science, the University of Colorado in Denver and Harvard University have overcome this problem by fabricating a nanoSQUID on a sharp quartz tip to make a scanning SQUID microscope.

Finkler and co-workers started by stretching a quartz tube to make a hollow tip, and then coating two regions on opposite sides of the tip with 25 nm of aluminium to create two leads. Next they coated the apex of the tip, which is circular, with 17 nm of aluminium. When the device was cooled below 1.6 K, the aluminium became superconducting, with the two sections of the apex that were in not contact with the leads forming 'weak' links between the two 'strong' superconducting regions that were in contact, thus making a SQUID. The device made by Finkler and co-workers has the smallest area of any SQUID reported so far, but its flux sensitivity is comparable to that of state-of-the-art devices.

MODELLING

Fine finish

ACS Nano doi:10.1021/nn901296y (2010)

Leukocytes, a type of white blood cell, carry a host of molecules that enable them to sense the location of wounds around the body so that they can respond to damage by rolling to and localizing in the affected area. Inspired by the role of leukocytes, researchers at the University of Pittsburgh have designed an artificial leukocyte that can repair a crack in a surface, by simulating the parameters required to roll spheres over a surface.

Anna Balazs and colleagues modelled the rolling motion of an amphiphilic (having both hydrophobic and hydrophilic character) microcapsule over a surface containing cracks. The compliant microcapsule has a thin wall and contains hydrophobic nanoparticles, which act as healing agents that get deposited when the capsule lodges in a crack. A range of shear rates and capsule–surface interaction parameters exist for arresting a capsule in a crack and depositing a maximum number of nanoparticles. Pulsatile shear-flow conditions that involve alternating high and low shear rates allows the capsule to localize and repair one site before continuing on to the next fissure in a 'repair and go' fashion.

Although the simulations involved the action of a single microcapsule, the parameters are expected to apply in actual systems because a high volume of capsules are available for repair. Such a fluid-driven repair system for surface defects may potentially be very attractive for precision materials.