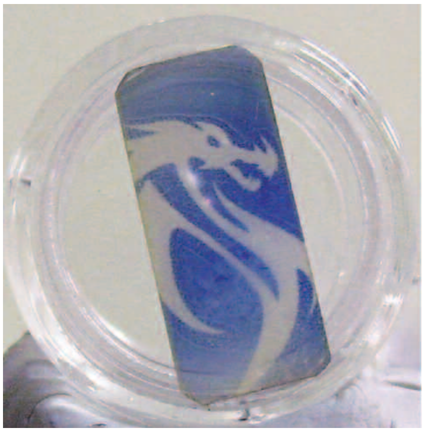
Optical response of Rb and Cs nano-particles in porous silica

Adsorption, desorption and nanoparticle formation processes are of great importance in the study of surface interactions. The possibility to understand and to modify the underlying mechanisms has a remarkable impact on fundamental physics as well as on technological applications. Indeed, the ability to control the adsorption/desorption and nucleation rates opens the way for the fabrication of nano-structured surface layers and nano-particle arrays.

We studied the influence of optical radiation on adsorption/desorption and cluster growth of Rb and Cs alkali metals confined at the nano-scale. Atomic layers and quasi-spherical nano-particles are formed in a nano-porous glass template by vapour diffusion in the dark. As light hits the porous matrix, the equilibrium inside the nano-pores between nano-particles, atomic layers and vapor phase, is suddenly shifted. In fact light, depending on its frequency and intensity, detaches atoms either from clusters or atomic layers. A small part of the desorbed atoms diffuses out of the porous sample, while the others, trapped in the glass matrix, re-condense on the pore walls, forming either nano-particles or layers. Therefore light moves atoms from layers to clusters and vice versa. The shift direction is clearly visible as particle formation induces a deep bluish coloration of the porous sample (Fig.).



▲ Dragon's picture recorded on porous glass loaded with Rb. The sample region exposed to light becomes blue due to the increase of the number of Rb nano-particles with respect to the equilibrium condition in the dark.

Furthermore, we found that the nano-particles formed in the dark, as well as the ones grown by light, are almost identical in size and shape. Therefore light increases or decreases the number of nano-particles dispersed in the porous sample without substantially affecting their structural properties. This result provides clear evidence that the confinement geometry imposes tight conditions on the equilibrium configuration of the existing clusters. ■

A. Burchianti, **A. Bogi**, **C. Marinelli**, **C. Maibohm**, **E. Mariotti**, **S. Sanguinetti** and **L. Moi**, 'Optical characterization and manipulation of alkali metal nanoparticles in porous silica', *Eur. Phys. J. D* **49**, 201 (2008)

Imaging frictional stresses

One of the main origins of complexity in the study of friction comes from the roughness of the contacting surfaces. When macroscopic bodies are pressed together, contact only occurs at localized spots between surface asperities. Friction thus involves the shearing of a myriad of micro-contacts, which are distributed over length scales ranging from micrometers down to nanometers. Although widely debated, the way in which these micro-contacts locally dissipate energy remains obscure. As a prerequisite, one should know how frictional stresses are distributed within the highly heterogeneous stress and strain field of macroscopic contact interfaces. Unfortunately, most experiments only rely on measurements of friction force and of its dependence on load and velocity, which are averaged quantities of local frictional properties. We recently proposed a method to measure local friction of rubbers with a contact imaging approach. Silicon rubber substrates marked beneath their surface by a coloured pattern were prepared in order to measure the displacement field induced by the steady state friction of a glass sphere. As reported in European Journal of Physics E, the de-convolution of this displacement field provides a spatially resolved measurement of the actual shear stress distribution at the contact interface. The results showed that the simple hypothesis based on the actual contact area and a constant shear stress (often utilised in rough contact models) cannot account for the observed shear stress distribution. Much work remains to be done, but one of the promises of this method is the possibility of investigating local friction between patterned surfaces with well controlled topography at the micrometer length scale. ■

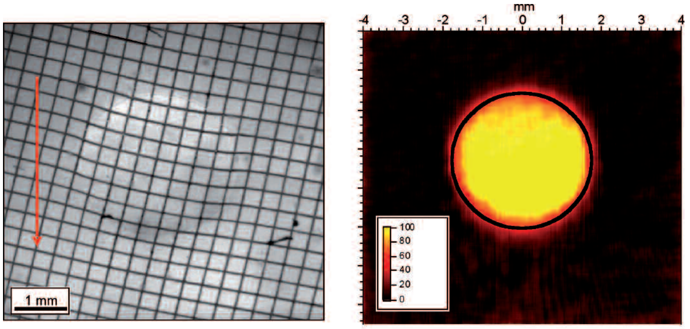


Image of the deformed contact zone

Surface shear stress distribution

◄ Friction between a marked silicone rubber and a glass sphere. Deconvolution of the measured surface displacement field provides the distribution of shear stress within the frictional contact.

A. Chateauminois and **C. Fretigny**, 'Local friction at a sliding interface between an elastomer and a rigid spherical probe', *Eur. Phys. J. E* **27**, 221 (2008)