Nanoscale science on metal oxide surfaces

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Scanning probe methods have played a crucial role in allowing us to understand chemical and physical processes on oxide surfaces. This talk will highlight some important advances using three substrates as examples, namely TiO_2(110), CeO_2(111) and Fe_3O_4(111). All three materials are important model catalysts, while TiO_2 has potential as a substrate for templating nanoscale circuits. Attention will first focus on imaging the water surface chemistry of TiO_2(110) and Fe_3O_4(111) as well as related reactions with O_2 and SO_2 for comparison with DFT calculations. Reactions with TiO_2(110) are dominated by oxygen vacancies, while only one termination of Fe_3O_4(111) reacts with water. The interaction of Pd with CeO_2(111) will be used to provide a bridge between the surface chemistry and surface engineering parts of the talk. Here we are interested in the redox behaviour of the system, the results pointing to charge transfer from Pd to CeO_2. This is important in connection with the use of Pd/CeO_2 as a CO oxidation catalyst. The second part of the talk will examine the potential for TiO_2(110) to self-assemble Pd, guide the substrate structure of TiO_2 through ultrathin film growth and be modified by electron beams. Using scanning tunnelling microscopy and X-ray photoelectron microscopy we show that it is possible to grow 1 μm long metallic wires of width 3 nm. Formation of reduced ultrathin films results in well defined shear plane structures that offer the potential to template linear structures. Electron beams are shown to form well defined reconstructed areas, with a mechanism that probably involves local heating.

Topic: Surface Science