

Rolf Schuster



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Principal Research Interests

The focus of our research is on physical and chemical properties of surfaces and solid-liquid interfaces. Currently we are investigating the following aspects:

- The formation of structures during the equilibration of a perturbed system is a rather general phenomenon, reaching from nucleation of water droplets in clouds to the spinodal decomposition process in magnetic alloys. At electrode surfaces in electrochemical environment such ordering processes can be induced very fast by changes of the electric potential. The subsequent ordering process can be *in-situ* observed by scanning tunneling microscopy. Fig. 1 shows an example of spinodal structures on an atomic scale, formed on a gold electrode surface.

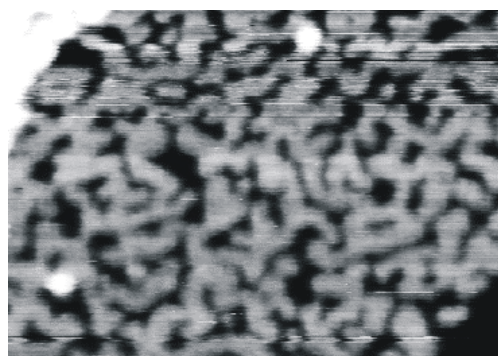


Fig. 1: Spinodal structures on a gold surface

Related scanning tunneling microscopy investigations are also performed in vacuum on single crystalline metal surfaces with particular respect towards underlying elementary processes like particle diffusion.

- We developed an electrochemical method for the machining of metal electrodes with machining precision down to the nanometer range. Electrochemical reactions are localized in the vicinity of a tool electrode by the application of ultrashort voltage pulses. Fig. 2 shows a spiral, machined into a nickel sheet. During the machining process the tool was first etched vertically into the surface and then fed along a spiral path, similar to an endmill in a milling machining.

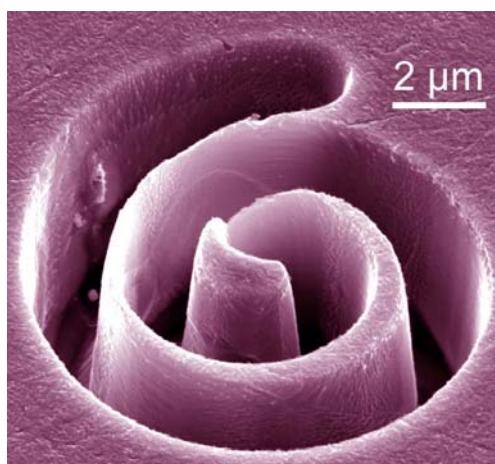


Fig. 2, Electrochemically machined spiral in a nickel sheet

- Shining light into the tip-surface gap in a scanning tunneling microscope enables local Raman spectroscopy on surfaces. A very intense electromagnetic near-field is formed in the tip-surface cavity, leading to an enhancement of the Raman signal by about six orders of magnitude. The Raman signal is originating from a surface area with about 40 nm diameter. In cooperation with the group of B. Pettinger at the Fritz-Haber-Institute in Berlin we are investigating the underlying enhancement process and testing the method with respect to applications in surface systems.

Representative Publications

- 1) Schuster R., Kirchner V., Allongue P., and Ertl G. (2000) Electrochemical micromachining, *Science* **289**, 98-101.
- 2) Trimmer A.L., Hudson J. L., Kock M., and Schuster R. (2003) Single-step electrochemical machining of complex nanostructures with ultra-short voltage pulses, *Appl. Phys. Lett.* **82**, 3327-3329.
- 3) Schuster R., Thron D., Binetti M., Xinghua X., and Ertl G. (2003) Two-dimensional nanoscale self-assembly in a gold surface by spinodal decomposition, *Phys. Rev. Lett.* **91**, 066101.
- 4) Ren B., Picardi G., Pettinger B., Schuster R., and Ertl G., (2005) Tip-enhanced Raman spectroscopy of thiophenol adsorbed on Au and Pt single crystal surfaces, *Angew. Chem. Int. Ed.* **44**, 139-144 (*Angew. Chem.* **117**, 141-144 (2005)).
- 5) Wintterlin J., Trost J., Schuster R., Eichler A., and McEwen J.-S., (2006), Two-Dimensional Roughening of Adsorbate Islands in Thermodynamic Equilibrium, *Phys. Rev. Lett.* **96**, 166102.
- 6) Schuster R. (2007) Electrochemical Microstructuring with Short Voltage Pulses, *Chem. Phys. Chem.* **8**, 34-39.