

## TOPOGRAPHY AND CHARGE TRANSFER CHARACTERISTICS OF FERROCENETHIOLS ON (111) ORIENTED GOLD SURFACES BY SCANNING PROBE MICROSCOPY

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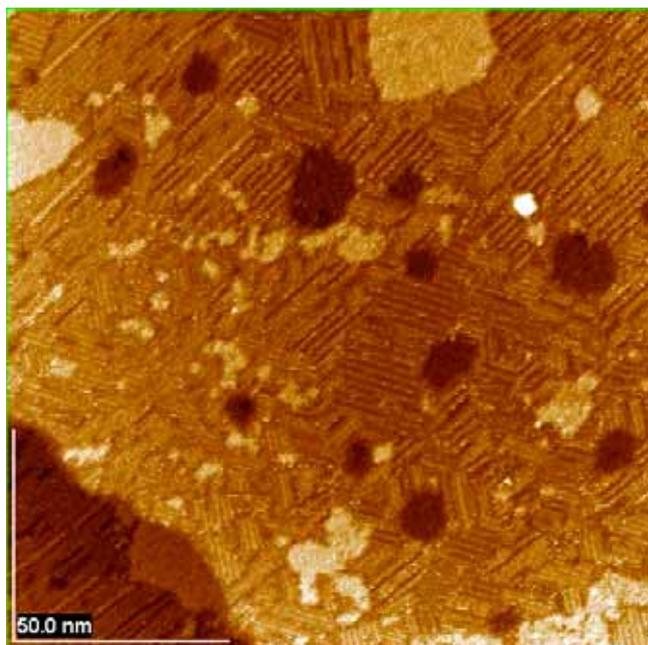
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The high demand for computational power has driven the silicon semiconductor industry to devices with nanoscale dimensions. At the same time as further downscaling of CMOS becomes more and more costly, the properties of individual molecules which are the smallest functional units in nature become accessible. This led to high research activity in the field of self-assembled monolayers (SAM's) [1] and molecular electronics [2]. One class of molecules which are especially interesting, are molecules with redox-active centers like ferrocene. Using such molecules the influence of the redox functionality on the charge transfer behavior through the molecule can be analyzed. Experiments concerning monolayers with ferrocene moieties as redox-active molecules were described by Usoaki et al. investigated ferrocenylalkanethiol monolayers by cyclic voltammetry and in-situ ellipsometry. Thereby he observed that these SAMs show intact redox behavior together with structural changes due to uptake of anions from the electrolyte of the oxidized ferrocene moiety [3]. Chidsey et al. attached ferrocenes to complete SAMs of azidoundecanethiol by "click"-chemistry and observed the redox behaviour of the resulting layer [4]. In this study ferrocenethiol and ferrocenedithiol monolayers are deposited from solution on Au(111) and characterized topographically and electronically by UHV-STM. Both kinds of molecules form rather disordered films. The film quality can be improved by annealing towards a weakly ordered monolayer. The topography of those monolayers shows the typical characteristics of a chemisorbed monolayer, such as etch pits, well known from other thiol/Au(111) systems [5], as well as substrate steps indicating a layer thickness roughly corresponding to a monolayer. In additional experiments the ferrocenethiols were inserted into an isolating matrix of alkanethiols to allow direct comparison to a well known system. Upon annealing these layers show a clear phase separation (Fig. 1). On both systems current/distance measurements and localized tunneling spectroscopy at different temperatures are conducted to address the charge transfer through the molecules.

**References:**

- [1] A.Ullman, Chemical Reviews, **96** (1996) 1533-1554.
- [2] C.R. Kagan, M.A. Ratner, MRS Bulletin, June (2004) 376-384.
- [3] T.Ohtsuka, Y. Sato, K. Uosaki, Langmuir, **10** (1994) 3658-3662.
- [4] J.P. Collman, N.K. Devaraj, C.E.D. Chidsey, Langmuir, **20** (2004) 1051-1053.
- [5] G.E.Poirer, Langmuir, **13** (1997) 2019-2026.

**Figures:**

**Fig. 1** STM-Topography of ferrocenethiol islands in an octanethiol self-assembled monolayer on a Au(111) surface. The striped areas show typical alkanethiol structures, whereas the islands of various size and shape consist of ferrocenethiols. The small dark areas are well known etch pits generated during the assembly process [5].