

**Self-Organized Growth of Transition-Metal Nanowires
on the 5×1-hex and 5×1-H Surfaces of Ir (100)**

*C. Giovanardi, A. Klein, A. Schmidt, L. Hammer, K. Heinz
Lehrstuhl für Festkörperphysik, Universität Erlangen-Nürnberg,
Staudtstr. 7, D-91058 Erlangen
Email: Chiara.Giovanardi@physik.uni-erlangen.de*

The clean (100) surface of iridium, Ir(100)-5×1-hex, and its hydrogen stabilized phase, Ir(100)-5×1-H, exhibit unidirectional structures laterally varying on the nanoscale. They can be used as templates for the self-organized growth of other material which is deposited to decorate these unidirectional structures, so forming new nanostructures. We present investigations using quantitative low-energy electron diffraction (LEED) and scanning tunnelling microscopy (STM) to observe and characterize the early growth and structures of deposited Fe, Co and Ni in the coverage range up to 0.4 monolayers (ML).

The Ir(100)-5×1-hex phase (fig. 1A) shows a strong vertical buckling along the [011] direction with a maximum amplitude of about 0.5 Å [1], so that there are unidirectional troughs. For all three elements - Fe, Co, Ni - an enhanced diffusion within these troughs is observed in the coverage regime below 0.25 ML. As a consequence, linear chains are formed (fig. 1B) whose lengths increase both with increasing coverage and substrate temperature. Laterally, the chains are mostly diatomic, but for Ni and Co also triple and quadruple rows are observed. The quantitative LEED analysis favours the long-bridge adsorption site for the atoms of the Fe dimers. The same holds for Ni dimers as directly imaged by STM. With the average coverage increasing beyond 0.25 ML, the hexagonal reconstruction is lifted locally, i.e. the chains within the troughs do not cover the whole surface.

Upon hydrogen adsorption, the clean Ir(100)-5×1-hex surface restructures in a way that the hexagonal reconstruction is lifted and the 20% excess atoms of the hexagonal top layer are expelled to the very surface. There they form an array of extremely long and defect free atomically thin Ir wires (fig. 2A), again with 5×1 periodicity on average [2]. The surface protruding Ir wires of this Ir(100)5×1-H phase can be decorated on both their sides. Deposition of 0.4 ML Fe leads to sandwiched wires, Fe-Ir-Fe, with each Ir row enframed by monoatomic Fe rows (fig. 2B). The full dynamical LEED intensity analysis reveals that Fe atoms occupy fourfold hollow sites of the quadratic Ir(100) layer below. In contrast, no preferential decoration of Ir wires is observed for both Ni and Co, i.e. neither Co-Ir-Co nor Ni-Ir-Ni sandwich chains form. Instead compact Co and Ni islands nucleate between the Ir wires whereby there is an attractive interaction between islands across the Ir. The wires remain unmodified with respect to both their position and length.

References

- [1] A. Schmidt et al., J. Phys.: Condens. Matter 14 (2002) 12353
- [2] L. Hammer et al., Phys. Rev. Letters 15 (2003) 9115

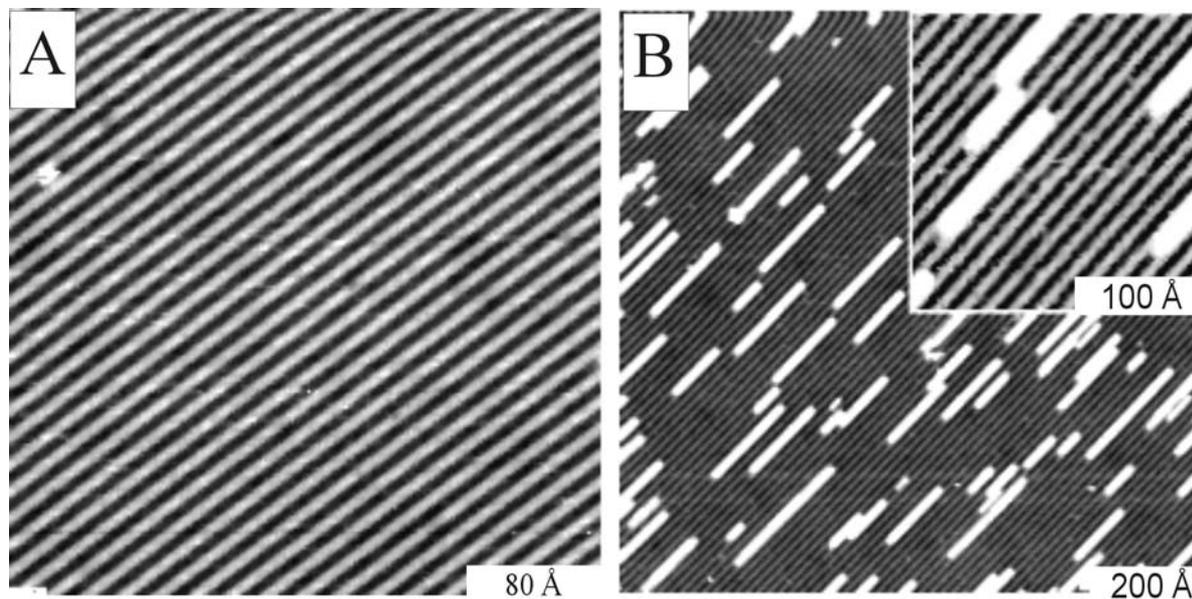


Fig. 1: STM images of the clean Ir(100)-5×1-hex surface (A) and after depositing 0.07 ML Fe (B)

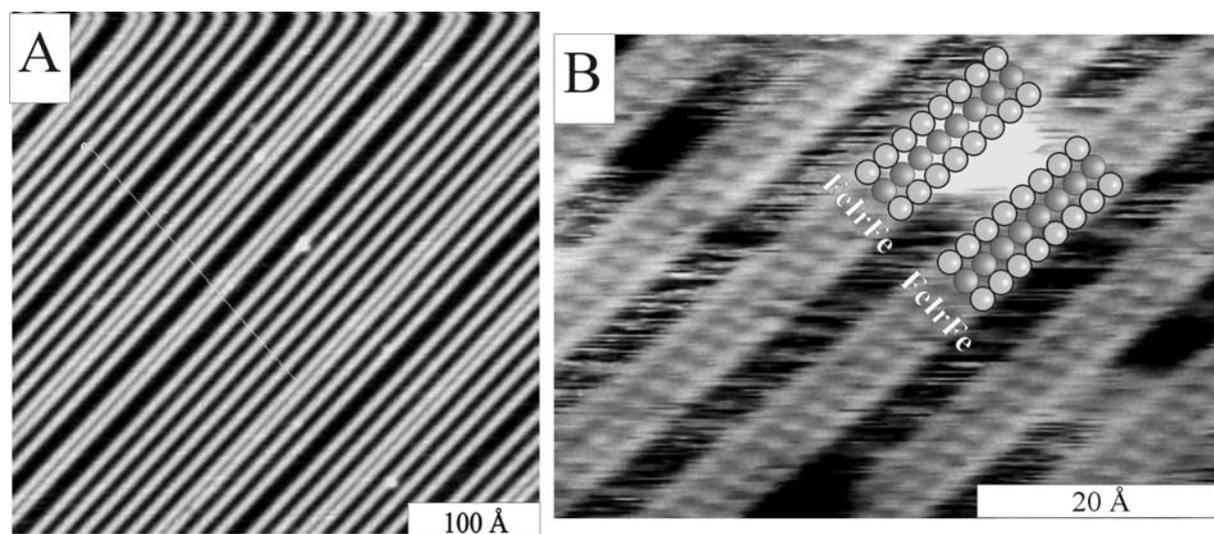


Fig. 2: STM images the of Ir(100)-5×1-H surface (A) and of 0.4 ML Fe / Ir(100)5×1-H (B)