26. October 2016 / 12 Uhr c.t., Raum MG 367
Campus Duisburg

Collective, multi-atom diffusion in epitaxial metallic films

Prof. Dr. Michael Tringides,

Department of Physics Iowa State University Ames Laboratory –USDOE, Ames, USA

Surface diffusion is the main process controlling mass transport in nature and determines the time scale of many important phenomena such as nucleation, nanostructure growth, phase transitions, pattern formation, chemical reactions. It is commonly described as a random walk of independently moving adatoms.

In this talk I will present a series of experiments in the epitaxial growth of Pb on Si(111) carried out over different length scales that challenge this classical picture. The experiments demonstrate that surface diffusion is not a stochastic process, but involves the correlated motion of ~million of adatoms to build uniform height islands[1].

STM and SPA-LEED experiments show that fully completed Pb crystalline islands, emerge “explosively” out of the compressed wetting layer after a critical coverage θ_c=1.22ML is reached. The unexpectedly high island growth rates and directional correlations show that mass transport is through the correlated motion of the wetting layer[2,3]. Real time experiments with LEEM, monitoring the refilling of an initial vacant area, show that the initial steep profile does not disperse and the profile propagates at constant velocity x~t (instead of the random walk time dependence $x \sim t^{1/2}$)[4]. The Pb/Si(111) can be also prepared in different “Devil’s Staircase” (DS) phases. C_{60} deposition experiments with STM show that Pb adatoms are ejected and transform extremely fast the initial DS phase to a perfect DS phase next in the phase hierarchy[5]. This is only possible via collective diffusion.

Experiments in other systems show that collective diffusion is a more general phenomenon. The formation of long anisotropic multi-height Ag islands on Ge(110) is exceedingly fast, when compared to the single atom Ag diffusion barriers, and also confirms the presence of collective diffusion[6].

[1] M. C. Tringides et al. in Physics Today 60, No. 4, 50 (2007), [2] M. T. Hershberger et al .Phys. Rev. Lett. 113, 236101 (2014), [3] H. Hattab et al. Surf. Sci. 646, 50 (2016), [4] K. L. Man, et al. Phys. Rev. Lett. ,110 036104, (2013), [5] A.V. Matetskiy, et al. J. Phys.: Cond. Mat. 25 395006 (2013), [6] S. Chiang et al. (in preparation).

Für diese Zeit steht eine Kinderbetreuung nach vorheriger Anmeldung zur Verfügung.

Contact: Prof. Dr. Michael Horn-von Hoegen, Faculty of Physics
Phone: +49 (203) 379 1438 / Mail: michael.horn-von-hoegen@uni-due.de@uni-due.de