Non-contact Atomic Force Microscopy of Model Catalysts: Pd / α–Al_2O_3(0001)

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Catalysts composed of metal particles on oxide surfaces are used in many industrial processes. Recent work has demonstrated enhancements in catalytic reactivity for nanometer-scale metal particles [V. Bondzie, et al., Catal. Lett. 63, 143-151 (1999)], attributed to a very high fraction of surface metal atoms in low coordination surface sites, such as step edges or kinks. A significant challenge in the development of transition metal catalysts is sintering of the catalysts at elevated temperatures, which leads to higher metal atom coordination and reduced surface area. We are studying the sintering kinetics of Pd nanoparticles on single crystal α-Al_2O_3(0001). A kinetic model of this sintering process will be valuable for the development and testing of future catalysts.

Non-contact atomic force microscopy is an attractive tool for studies of these particles. NC-AFM allows measurement of nanoparticle size, morphology, and number density, even when the particles are on an insulating substrate, such as alumina. However, there are specific challenges to studying oxide surfaces with NC-AFM. We will discuss the use of multi-walled C nanotube NC-AFM tips compared to conventional tips. Preliminary evidence suggests C nanotube tips allow better resolution of the smallest metal particles (see figure below). This work is supported by DOE OBES Office of Chemical Sciences and the M. J. Murdock Charitable Trust. SLT supported by a graduate fellowship from UW/Pacific Northwest National Laboratory Joint Institute for Nanoscience. LTN supported by NSF IGERT Nanotechnology fellowship.

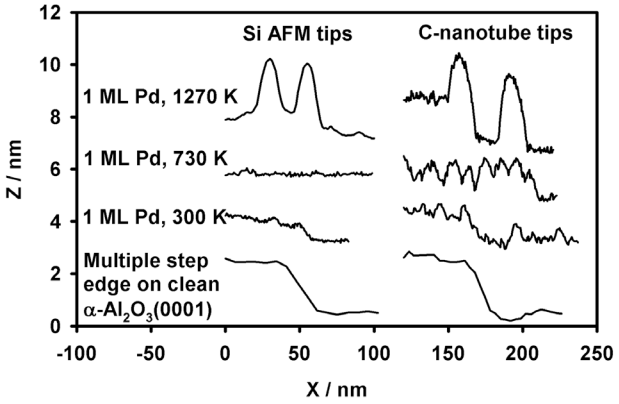

Figure 1. Line profiles of Pd nanoparticles on alumina surface after annealing to different temperatures. Left column of profiles measured with Si AFM tips, right column with C nanotube AFM tips. All profiles recorded at room temperature. Each profile was recorded at a different location on the sample.