Determining the energetics of supported bimetallic Au-Pd nanoparticles by aberration-corrected TEM

N. T. Nguyen[1], J. Nelayah[1]*, H. Prunier[1], D. Alloyeau[1], G. Wang[1], L. Piccolo[2], P. Afanasiev[2] and C. Ricolleau[1]

[1] *MPQ, CNRS & Université Paris Diderot, Paris, France*
[2] *IRCELYON, CNRS & Université Lyon 1, Villeurbanne, France*

The thermodynamics of metallic nanoparticles (NPs) is crucial in defining their structure and physical properties as well as their catalytic activity. However, experimental investigations of the energetics of metallic NPs are still lacking. In this contribution, we report on the experimental determination by electron microscopy of interface and triple-line energies in small fcc truncated Au-Pd octahedra epitaxially grown on rutile titania nanorods. With the precise equilibrium morphology of the NPs known, the interface and triple-line energies of the metal/oxide systems were determined by combining particle size measurements in atomically-resolved projected TEM images and a recently proposed generalized Wulff-Kaishew theorem. Interface and triple-line energies were investigated as a function of particle composition and epitaxy. On the rutile support, analysis of Au-Pd NPs in epitaxial relationship Au-Pd(111)<101>*//Rutile(110)[1-1-1]* shows clearly that the interface and triple-line energies are strongly influenced by particle composition. The value of the interface energy of the bimetallic Au-Pd NPs, $\gamma_{i,Au\text{-}Pd}$, is about 1 J m^{-2}, which is about two and three times that of the monometallic Pd and Au NPs, respectively ($\gamma_{i,Pd}$ = 0.5 ± 0.1 J m^{-2} and $\gamma_{i,Au}$ = 0.3 ± 0.2 J m^{-2}). The triple-line energy is 0.5 ± 0.1 J m^{-2} for the monometallic nanoparticles. This value is twice the average triple-line energy of Au-Pd NPs.