Innsbruck Physics Colloquium

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Core-shell nanoparticles prepared in superfluid helium droplets: Structure, phase transitions, and alloy formation

In our labs, superfluid droplets of 10^6 to 10^{10} helium atoms (HeN) are doped with foreign atoms or molecules that can form complexes in this cold environment. In this way, large Cu, Ag, Au, Ni, Pd, and Cr aggregates of different morphology are generated and deposited on solid carbon, BN, or SiN substrates. Employing different pick-up cells for doping the droplets, nanowires of 2 to 5 nm diameter and around 100 nm length, as well as core-shell clusters with one metal surrounding a core of a different species are produced. After surface deposition, the samples are removed and various measurement techniques are applied to characterize the created particles: scanning electron microscopy at atomic resolution, electron tomography [1], temperature dependent SEM and TEM up to 1000°C, energy-dispersive x-ray spectroscopy (EDXS), electron energy loss spectroscopy (EELS) and optical absorption. By varying the contents of different metals in core-shell particles, we can tune the plasmon resonance. Furthermore, results of our investigation of the thermal behavior of deposited nanoparticles [2] and the corresponding phase changes on the nanoscale will be reported [3] as well as their chemical reactivity [4].

[1] G. Haberfehlner et al., Formation of bimetallic clusters in superfluid helium nanodroplets analyzed by atomic resolution electron tomography, *Nature Communications* **6**, 8779-1-6 (2015). [2] M. Schnedlitz et al., Thermally induced breakup of metallic nanowires: Experiment and theory, *PhysChemChemPhys* **19**, 9402-9408 (2017). [3] M. Lasserus et al., Thermally induced alloying processes in a bimetallic system at the nanoscale: AgAu sub-5 nm core-shell particles studied at atomic resolution, *Nanoscale* **10**, 2017-2024 (2018). [4] M. Schnedlitz et al., On the stability of core-shell nanoparticles for catalysis at elevated temperatures: Structural inversion in the Ni-Au system observed at atomic resolution, *ACS Chemistry of Materials* **30,** 1113–1120 (2018).

Tuesday,24.4.2018, at 17:15 in lecture hall C

Innsbruck Physics Colloquium, Organisation: M. Beyer, H.-C. Nägerl, A. Reimer