

## **Abstract:**

Mass selected geometrically magic clusters from  $\text{Ag}^+_{55}$  to  $\text{Ag}^+_{923\pm 9}$  were deposited at 165 K on HOPG and Au(111) functionalized with monolayers (ML) of  $\text{C}_{60}$  molecules and imaged with scanning tunneling microscopy (STM) at 77 K. We observed extremely narrow cluster height distributions. The cluster heights are in good agreement with calculated heights by assuming a spherical shape of the clusters. We studied the thermally activated decay of the deposited clusters. Using  $\text{C}_{60}$ /HOPG or 2 ML  $\text{C}_{60}$ /Au(111) the cluster heights are stable for more than 12 h at room temperature (RT). For 1 ML  $\text{C}_{60}$ /Au(111) the clusters penetrate the  $\text{C}_{60}$  monolayer. Atomistic calculations reveal a process by which the clusters decay atom by atom through 1 ML  $\text{C}_{60}$ /Au(111) at RT due to a low barrier height for the transport of Ag atoms through the  $\text{C}_{60}$  layer. This barrier is much higher for clusters on 2 ML  $\text{C}_{60}$ . A sharp maximum at 1.5 nm cluster height forms during the cluster decay, indicating that there exists some metastable 'supported magic number'. The metastable cluster size also occurs by Ostwald ripening of  $\text{Ag}_{68}$  and  $\text{Ag}_{80}$  – geometrically non-magic clusters – after RT annealing.

In addition we investigated Ag islands which were formed by atom evaporation on  $\text{C}_{60}$ /Au(111) at  $T < 50$  K and annealed the Ag islands up to RT. The Ag islands on 1 ML  $\text{C}_{60}$  penetrate the  $\text{C}_{60}$  film already below RT and form islands below the  $\text{C}_{60}$  while the islands on 2 ML  $\text{C}_{60}$  grow by ripening and coalescence during RT annealing. In contrast grown Pb islands do not penetrate 1 ML  $\text{C}_{60}$ /Au(111) but grow due to coalescence and ripening.

In order to study the electronic structure ultraviolet photoemission spectra (UPS) of  $\text{Ag}^+_{55}$  and  $\text{Ag}^+_{923\pm 9}$  clusters were performed. Additionally for  $\text{Ag}^+_{309\pm 3}$  and  $\text{Ag}^+_{923\pm 9}$  clusters we used scanning tunnelling spectroscopy (STS) at 5 K and measured identical spectral features for individual clusters with the same selected size. The spectra can be classified in different groups showing energetic shifts of the peaks due to different shapes of the STM tip. For this reason we measured STS spectra of  $\text{C}_{60}$  molecules as reference.

Additionally the properties of  $\text{C}_{60}$ /Au(111) and  $\text{C}_{60}$ /HOPG were investigated. 1 ML  $\text{C}_{60}$ /Au(111) shows three different phases and different  $\text{C}_{60}$  orientations. For 1 and 2 ML  $\text{C}_{60}$ /HOPG three different orientations of single  $\text{C}_{60}$  molecules including intramolecular orientations were investigated with STM at 5 K which can be assigned to the pentagons and hexagons of the  $\text{C}_{60}$  molecules.

## **Keywords:**

Clusters, scanning tunneling microscopy, scanning tunneling spectroscopy, nanoparticles, fullerenes, fullerene-related materials, nanocrystalline materials