Interdiffusion-Induced Forming of AuPd Bimetallic Nanowhiskers

Anuj Bisht[a], Michael Kalina[a], Eylül Suadiye[b], Gunther Richter[b], Eugen Rabkin[a]

[a]*Department of Materials Science and Engineering, Technion – Israel Institute of Technology, 3200003 Haifa, Israel*

[b]*Max Planck Institute for Intelligent Systems, Heisenbergstrasse 3, 70569 Stuttgart, Germany*

[a]*anujbisht@campus.technion.ac.il*

Controlled plastic deformation of defect-free metallic nanocrystals is a challenge because they fail catastrophically by stochastic avalanche of nucleated dislocations. We propose employing chemical interdiffusion for controlled plastic deformation of the nanoscale objects. We demonstrate controlled bending of ultra-strong bimetallic Au-Pd nanowhiskers via in-situ thermal actuation in scanning electron microscope. The bimetallic nanowhiskers were produced by molecular beam epitaxy, whereas as-grown Au nanowhiskers were coated on one side with Pd. The two internal interfaces in the whiskers were Au-Pd heteroepitaxial interface and a coherent twin boundary in the parent (Au) whisker. The produced bimetallic nanowhiskers were slightly bent due to heteroepitaxial stresses at the Au-Pd interface. Nanowhiskers annealing resulted in a change in curvature and additional bending. Three bending mechanisms activated with increasing temperature were identified as thermal stresses, local interdiffusion and loss of coherency across the Au-Pd interface, and bulk interdiffusion leading to full homogenization. The bending behavior of the nanowhiskers was correlated with their microstructure determined via ex-situ cross-sectional characterization. Single crystalline nature of nanowhiskers was preserved all through.

Keywords: Nanowhiskers, Diffusion, In-situ annealing, HR TEM, Theoretical model.

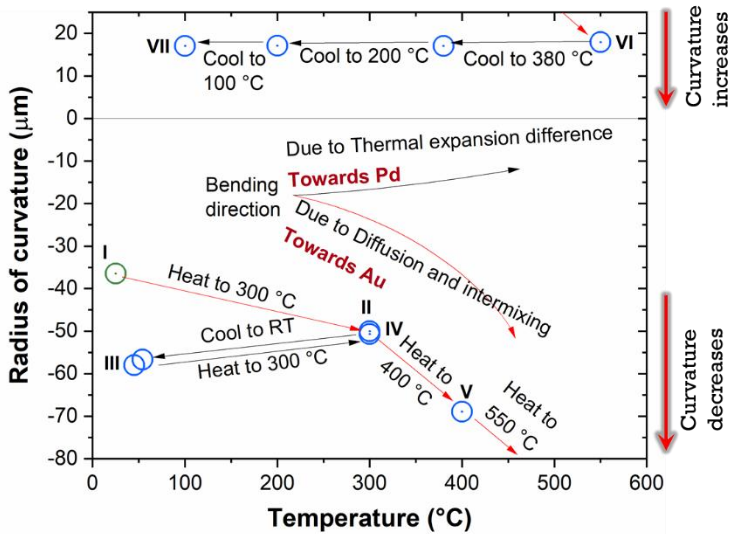

Fig.1 Thermal curvature evolution of AuPd bimetallic nanowhisker.