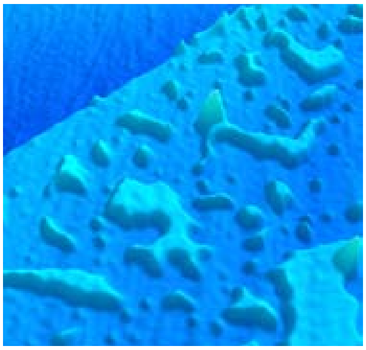
Trapping water monolayers with graphene allows AFM imaging

Layers of water molecules are present on all hydrophilic surfaces, yet studying these dynamic structures at room temperature is problematic. Imaging them with scanning probe microscopy is usually hindered by the formation of a capillary meniscus between the tip and sample. K. Xu of Harvard University and P. Cao and J.R. Heath at the California Institute of Technology have managed to overcome this difficulty by trapping water adlayers on mica beneath a monolayer of graphene.

As reported in the September 3rd issue of *Science* (DOI: 10.1126/science.1192907; p. 1188), Xu and co-workers deposit a layer of graphene onto mica through mechanical exfoliation, and identify monolayer regions using spatially resolved Raman spectroscopy. Imaging the surface with an atomic force microscope (AFM) under ambient conditions reveals raised regions of graphene thought to be the result of water monolayers trapped beneath it. The height of these islands (corresponding to a layer of ice), and the strong influence of the humidity conditions on the trapped layers point to their identity as water molecules. The monolayer islands form polygonal shapes, with geometries which suggest an ice-like structure formed epitaxially on the mica.



The atomic force micrograph shows monolayer islands of water trapped beneath a graphene sheet. More liquid-like water droplets are indicated by the higher peaks.

Imaging at varying relative humidity sheds further light on the mechanism of monolayer formations and their evolution at higher coverages. At low humidity (<2%), water islands could only be seen on mica with lots of surface defects. A tendency for the islands to connect defects demonstrates that defects play a role in nucleation of the monolayer. At higher humidity (~90%), complete monolayers were observed, as well as second layer islands, again often associated with surface defects. The height and geometry of these second layers were also in agreement with an ice-like model.

These results help elucidate a growth mechanism for water adlayers on mica that is remarkably similar to epitaxial growth in well-known inorganic systems. A complete monolayer is formed before the buildup of strain results in islands at higher coverages.

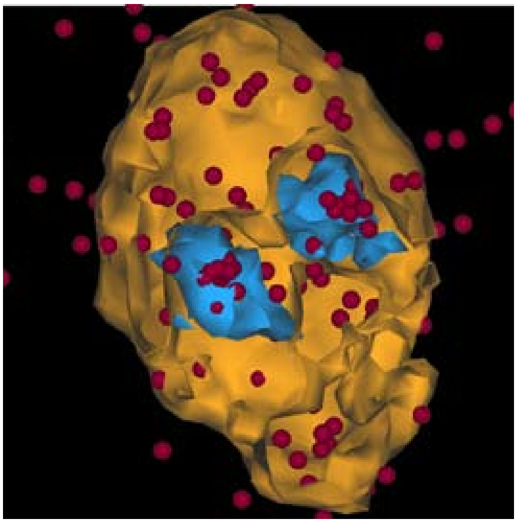
Tobias Lockwood

Nano Focus

Multishell nanoparticles created within a solid matrix

Particle inclusion in solid matrices is a common strategy used to tailor the properties of structural metallic alloys, such as strength or aging at elevated temperatures; however, it is a complicated story. Requirements for these particles that affect their interaction with dislocations and coarsening resistance are an often contradictory mix of stiffness, shearability, lattice parameter mismatch, diffusivities, and interfacial energies among other considerations. Earlier studies of solid-state precipitation within metallic alloys have focused on chemically homogenous nanoparticles. The ability to generate and tune more complex, chemically heterogeneous nanoparticle structures could lead to increased control over the macroscopic properties of important structural alloys. In a communication recently published in the August 16th issue of *Small* (DOI: 10.1002/smll.20100325; p. 1728) C. Monachon, D.C. Dunand, and D.N. Seidman of Northwestern University (Monachon now at EPFL, Switzerland) report a solid-state synthesis of nanoparticles with a core and two concentric shells within an aluminum-based alloy matrix. While this nanoparticle architecture has been achieved in solution-based syntheses, this work represents the first demonstration of multishell nanoparticles created within a solid matrix.

Their nanoparticles are created using a two-step aging protocol on an aluminum-based alloy



Atom-probe tomography reconstruction of a “double-yolk egg” nanoparticle containing two Yb-rich $Al_3(Li,Yb,Sc)$ cores, surrounded by their respective Sc-rich $Al_3(Li,Sc,Yb)$ first shells and a common δ'-Al_3Li second outer shell. Yb atoms are shown in red, Sc-rich regions in blue, and Li-rich regions in yellow. Image courtesy of David Seidman. Reproduced with permission from *Small* **6** (16) (2010) DOI: 10.1002/smll.20100325; p. 1728. © 2010 WILEY-VCH Verlag GmbH & Co.