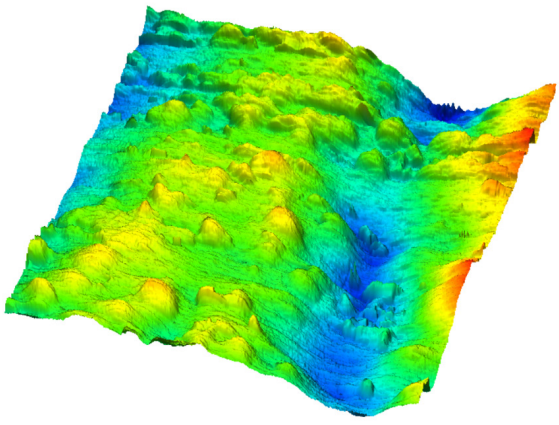
nGauge AFM

Polymers and Composite Research Using the nGauge AFM

The nGauge Atomic Force Microscope (AFM) is a power tool for characterization of polymers and composites. In three clicks, the nGauge is able to provide both topographical and mechanical data with high spatial accuracy.

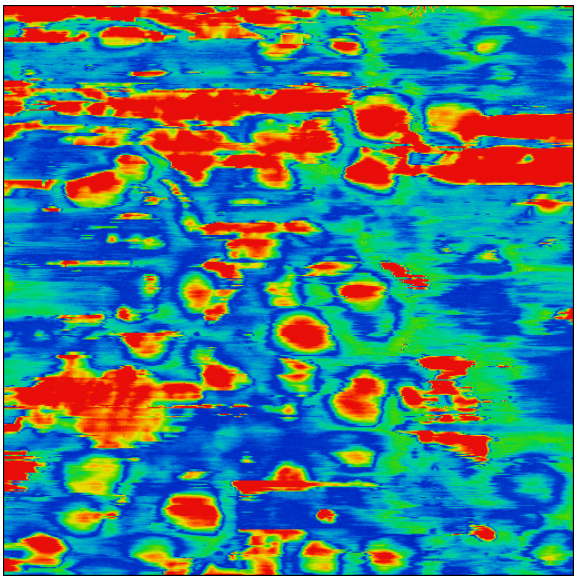
Topography data is straightforward—this data is gathered by scanning across the sample to measure the height of features by repeatedly tapping each point with the AFM tip. This allows users to measure the size of features on samples with a high degree of precision.

As the tip of the AFM scans across the sample in tapping mode, the interaction between the tip and the sample will cause the feedback signal to lag behind the driving signal. This is the “phase shift” of the signal and typically depends on the adhesive, frictional and viscoelastic forces experienced by the tip. This data can be used to create a “phase image” which gives qualitative information about the mechanical properties of the surface. More can be found on our phase imaging blog post. Phase imaging mode is included in the nGauge AFM software by default and is automatically obtained together with the topographic data in a regular scan, without any additional setup.



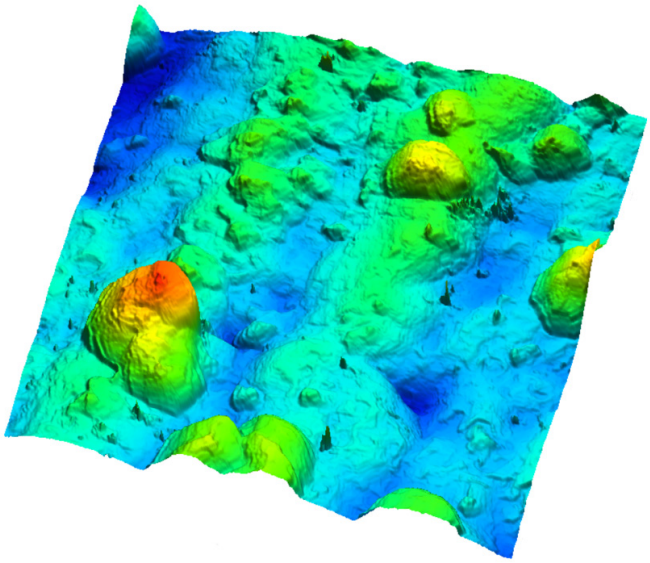
3D topography of ABS under the nGauge

The difference between the topographical and phase data is particularly evident when looking at a copolymer such as Acrylonitrile-Butadiene-Styrene (ABS) terpolymer. Under topography mode, the scan is not particularly useful—it is possible to see some distinct structures, but it is hard to tell if different materials are present. These features are also likely to be more indicative of the polishing or cutting process used to prepare the sample than any intrinsic property of the polymer itself.



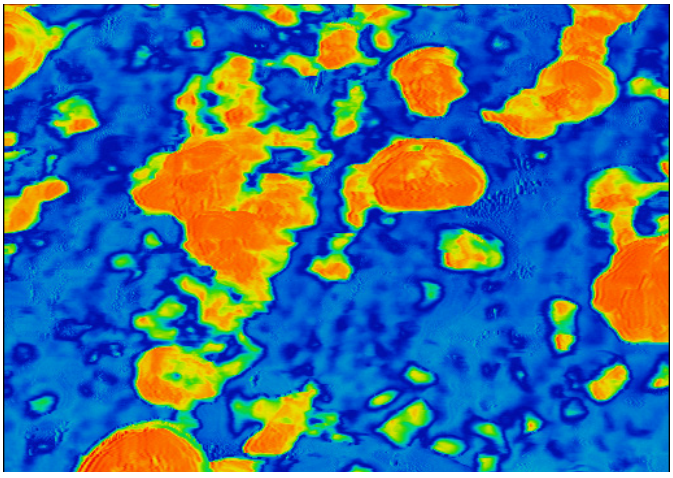
Phase image of ABS under the nGauge

In phase mode however, the contrast is higher between components in the material. It becomes clear that the material is heterogeneous on the nanoscale. Due to difference in the mechanical properties of the components, the phase image can be used to locate butadiene pockets dispersed in the sample (red areas in the phase image). The topography and phase images are collected simultaneously so the location of the butadiene pockets from the phase image can be used to correlate the pockets in the topography image.



3D topography of silica-polymer composite under the nGauge

The nGauge is capable of looking at many different types of polymers and composites. Other than co-polymers, composite materials are also a great candidate for analysis by the nGauge AFM. For example, in the below topography image of a silica-polymer composite, although a few large silica particles on the surface can possibly be seen (larger features), it is difficult to determine precisely which features are composed of the polymer matrix and which are composed of silica.



Phase image of silica-polymer composite under the nGauge

However, under phase imaging, there is much better contrast between the silica particles (red) and the polymer matrix (blue). Here, it is trivial to determine the size, shape and distribution of silica particles in the polymer matrix, which are critical parameters that determine the mechanical properties of the resulting composite material, demonstrating one of the unique advantages of AFM.