Applications of AFM in Film Studies

Contents

- What is Atomic Force Microscopy?
- SEM, TEM and AFM
- Application of AFM in polymer tech.
- Application of AFM in film studies

Atomic Force Microscopy

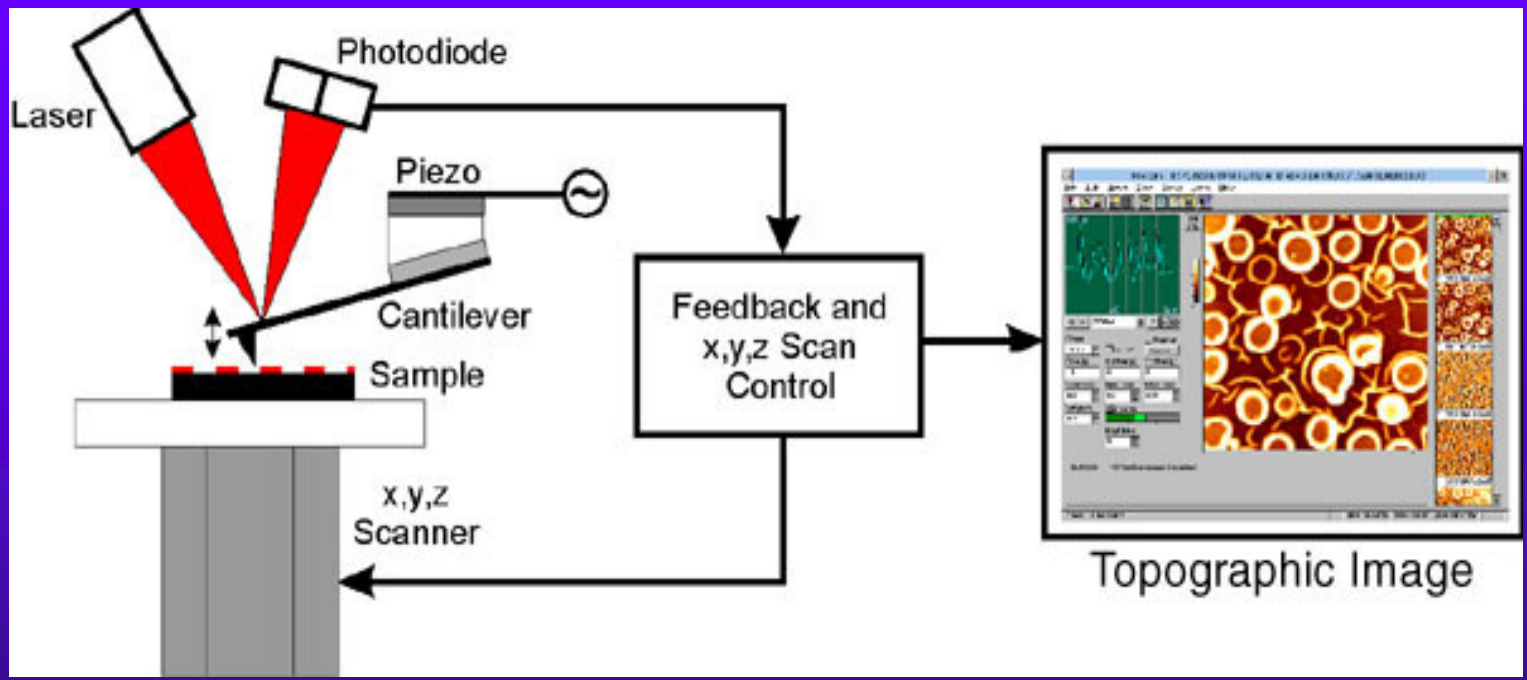


Figure Schematic of an atomic force microscopy (AFM) showing the force sensing cantilever.

Advantages of AFM

- Highest resolution available:
  AFM's lateral resolution allows imaging and measurement of features on the order of a few nanometers; the vertical (height) resolution is <1Å.

- Quantitative 3-D surface maps:
  AFM images can be computer-rendered with any tilt or rotational angle, and provide accurate measurements in all three dimensions on features of interest.

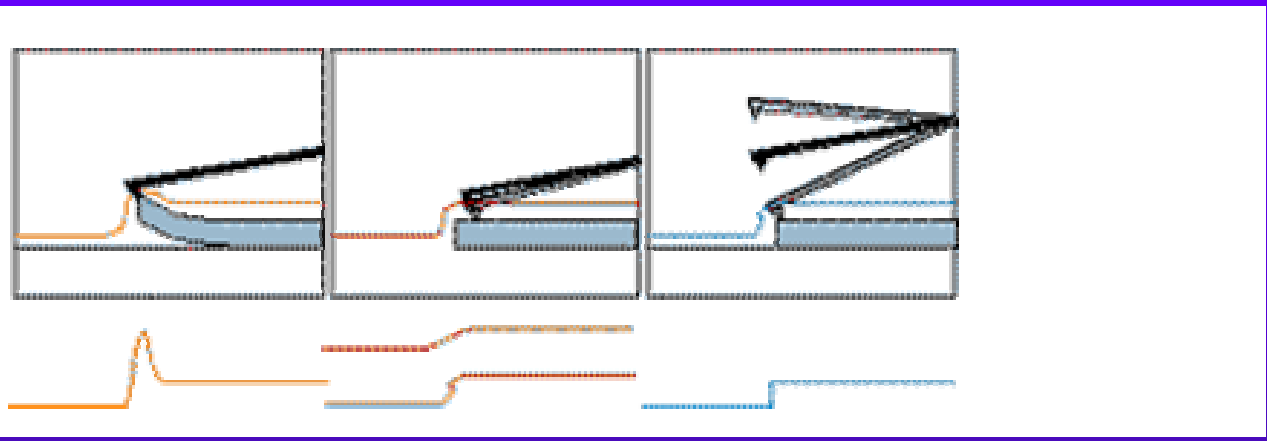
- Operation in liquid:
  AFM can characterize contact lenses in their native liquid environment. With TappingMode AFM, the lens can be worn again after imaging, tested or further processed, and then re-imaged to provide images of a time-series of repetitive exposures.

Advantages of AFM

- Non-destructive:
  Whether in air or in liquid, the AFM characterizes the sample without damage.

- Materials properties characterization:
  The AFM actually combines several techniques in a single instrument. On and near the surface, topography, adhesion, viscoelasticity, hardness, friction, and other properties can be revealed - again, with nanometer resolution.

Contact Mode, Non-contact Mode and Tapping Mode



Contact mode imaging (left) is heavily influenced by frictional and adhesive forces which can damage samples and distort image data. Non-contact imaging (center) generally provides low resolution and can also be hampered by the contaminant layer which can interfere with oscillation. TappingMode imaging (right) eliminates frictional forces by intermittently contacting the surface and oscillating with sufficient amplitude to prevent the tip from being trapped by adhesive meniscus forces from the contaminant layer.

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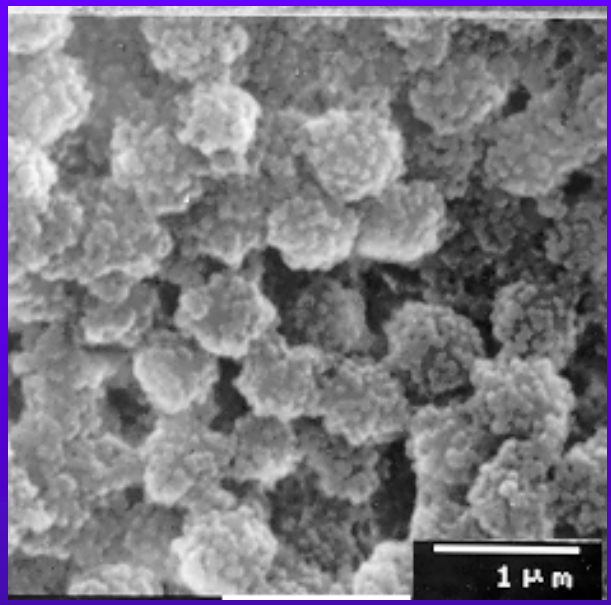
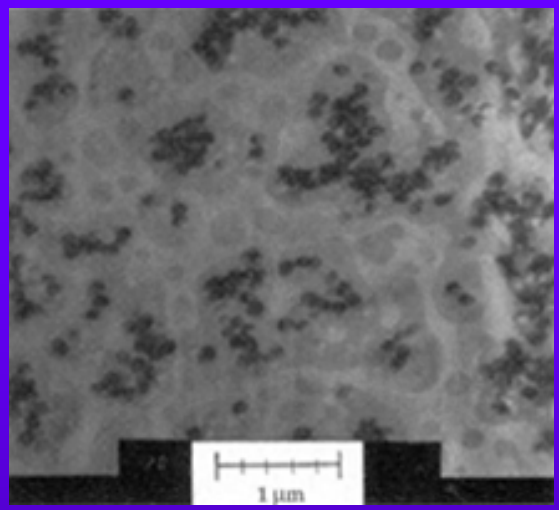
SEM vs. AFM



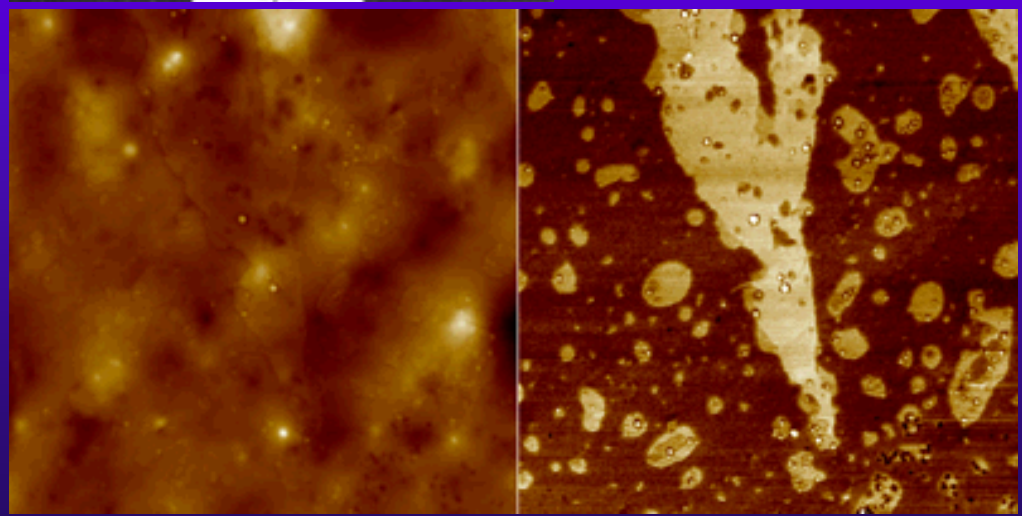
Images of a "raspberry" polymer. Due to the fragile nature of this sample, non contact imaging was the only mode that could be used to successfully scan the sample.

Hyun-Jae Ha, Young-Jun Park, Jung-Ho Ahn, Jung-Hyun Kim, *Polymer International*, 44, 490

TEM vs. AFM



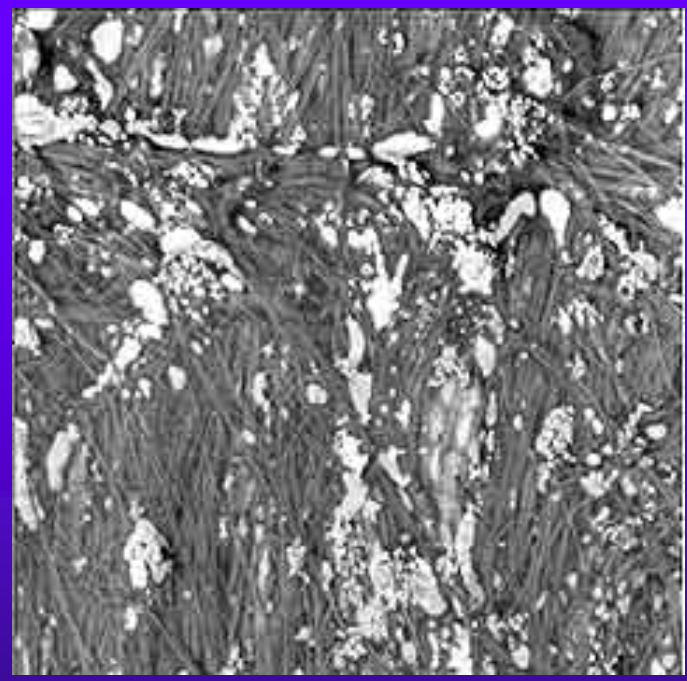
Transmission electron micrograph of impact-modfied plastic containing three components. Differences in the contrast are a consequence of chemical staining of the sample.



AFM height (left) and phase (right) images

van den Berg R, de Groot H, van Deijk MA, Denley DR. Polymer 1995; 35:5778.

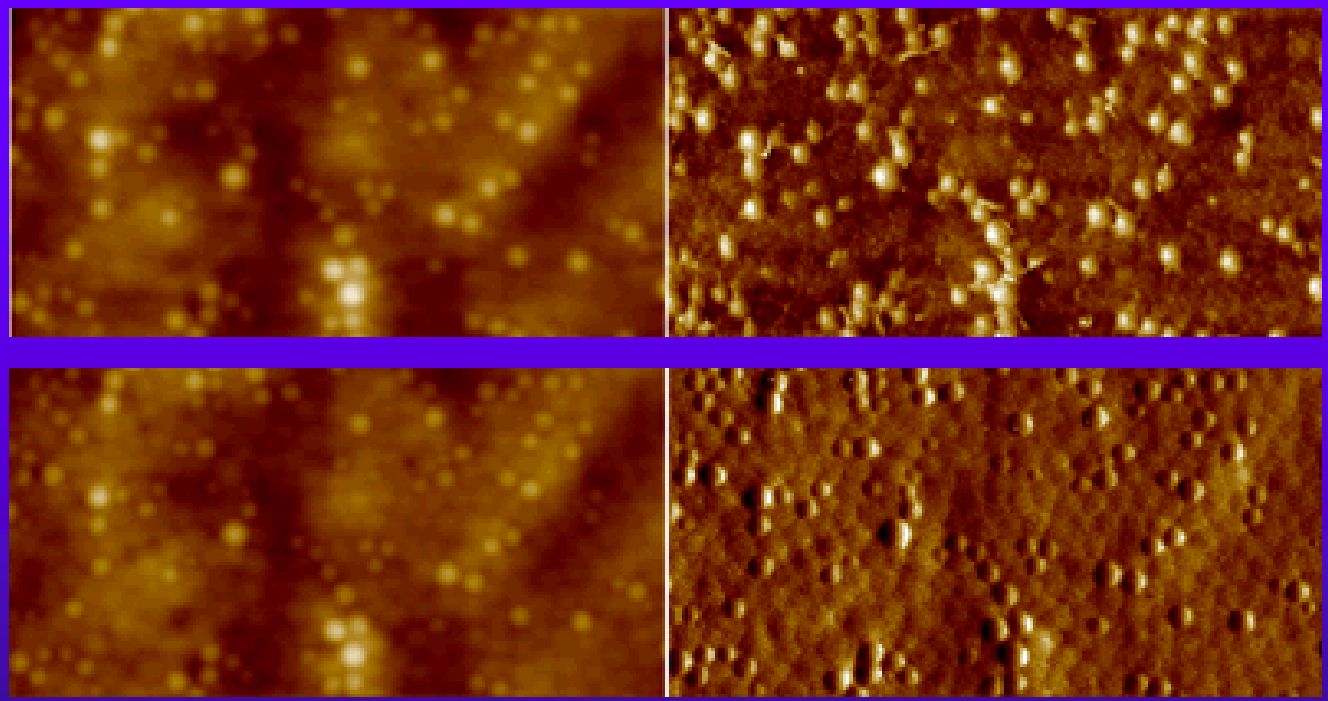
Phase Imaging :
Compositional Mapping



Phase Imaging is quite effective for mapping the sub-micron properties of multi-component polymer systems based on the relative elasticity of individual components.

Magonov SN, Reneker D. Characterization of Polymer Surfaces with Atomic Force Microscopy. Ann Revs Mat Sci 1997; 27:175

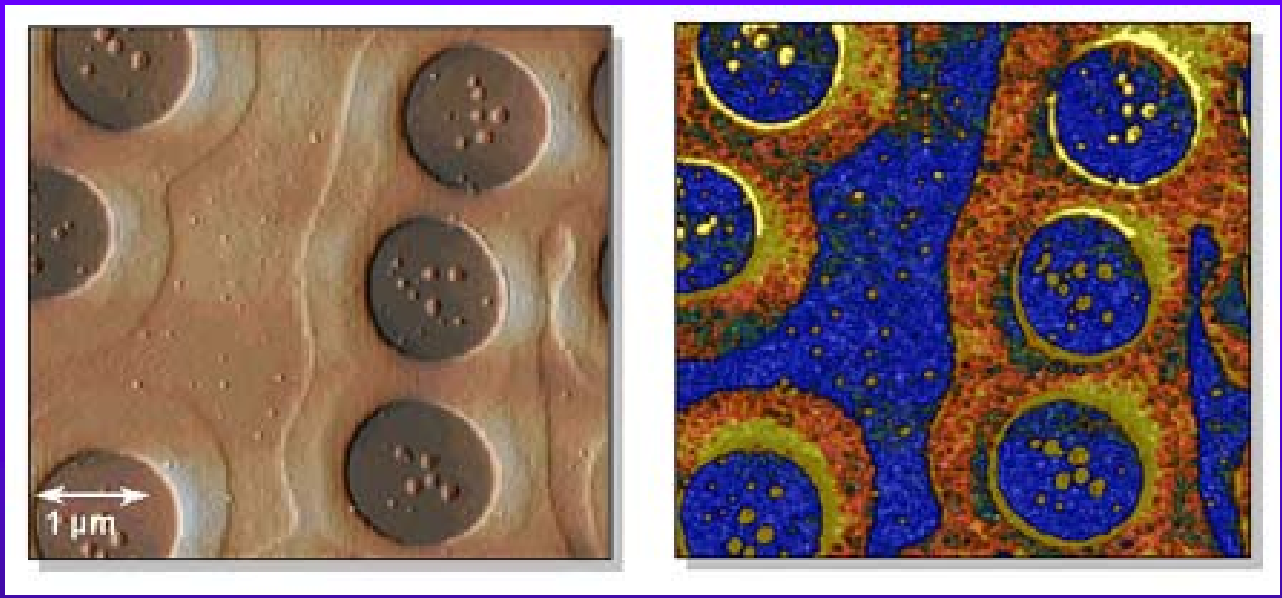
Phase Imaging



AFM height (left) and phase (right) images of a two-component latex blend consisting of spheres of about 120nm diameter.

Young-Jun Park, Michael J. Monteiro, Steven van Es, Anton L. German, *Eur. Polym. J.*, 37, 965-973 (2001)

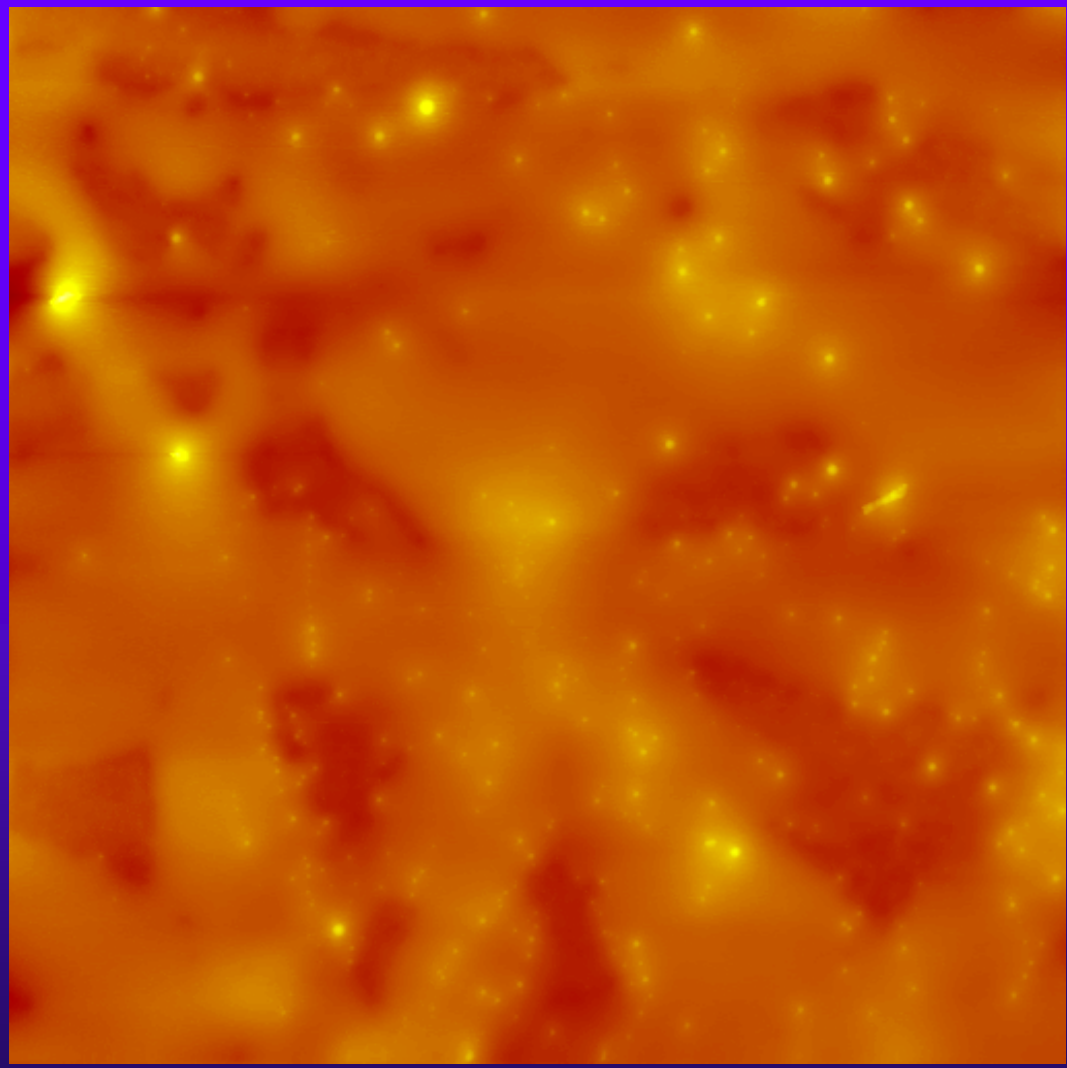
Adhesion Imaging



Topography (left) and adhesion (right) images of spin casted polymer (PS/PMMA).

Witec Gmbh, Ulm, Germany

Imaging with Time



Syndiotactic Polypropylene : 120 Degrees C, With Fading, 40μm Scan Crystallization in Less Than 1 Hour.

Whangbo M-H, Magonov SN, Bengel H. Probe Microscopy 1997; 1:23.