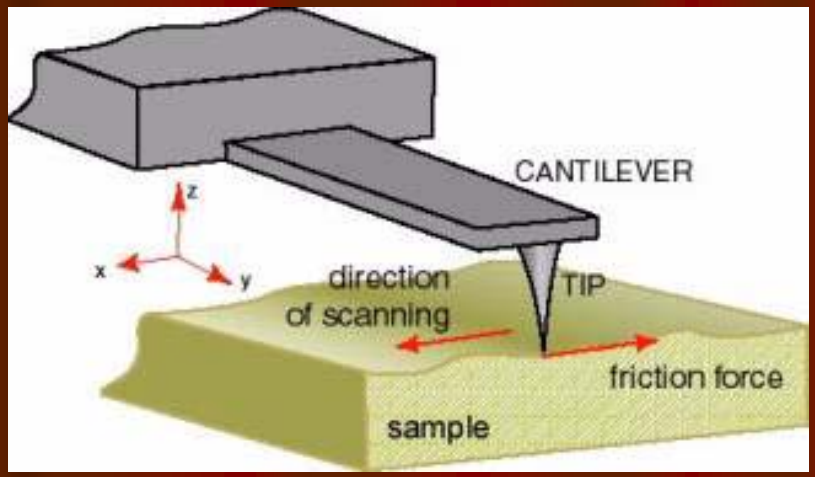
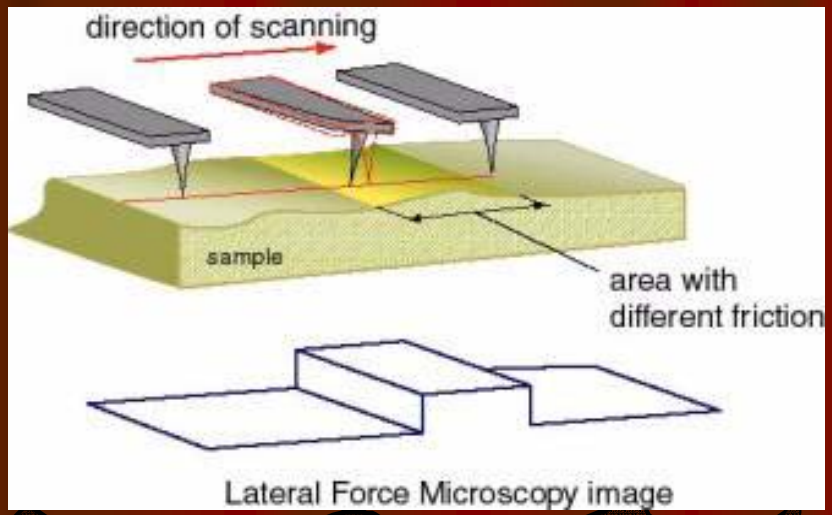
Alternative imaging modes



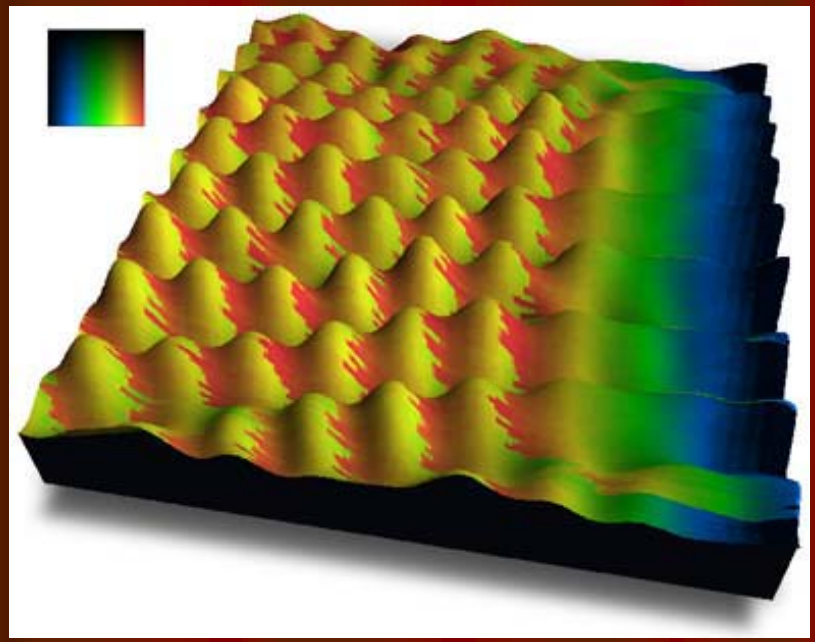


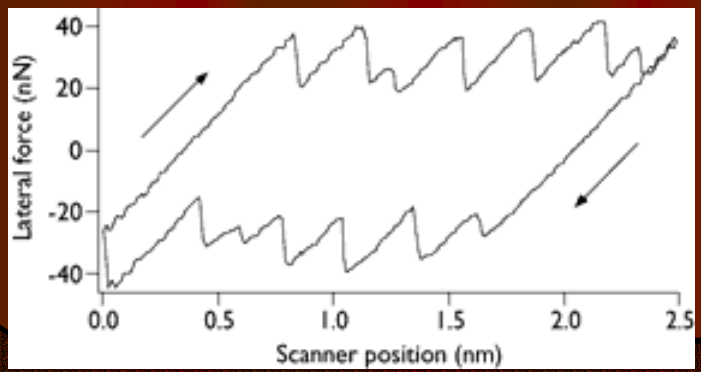
Lateral Force Microscopy image

Lateral Force Microscopy (LFM)

- **While topographic imaging uses the up-and-down deflection of the cantilever, friction imaging uses torsional deflection.**
- If the scanner moves the sample perpendicular to the long axis of the cantilever, friction causes the cantilever to twist. A photodetector can distinguish the resulting left-and-right motion of the reflected laser beam from the up-and-down motion caused by topographic variations

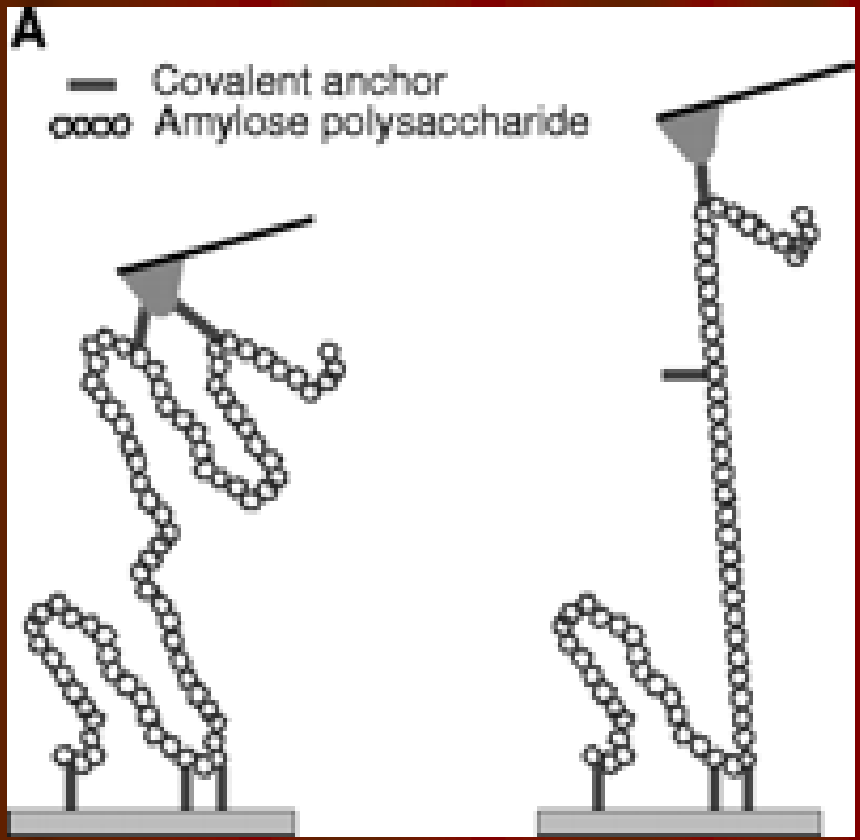
AFMs can measure the friction between tip and sample





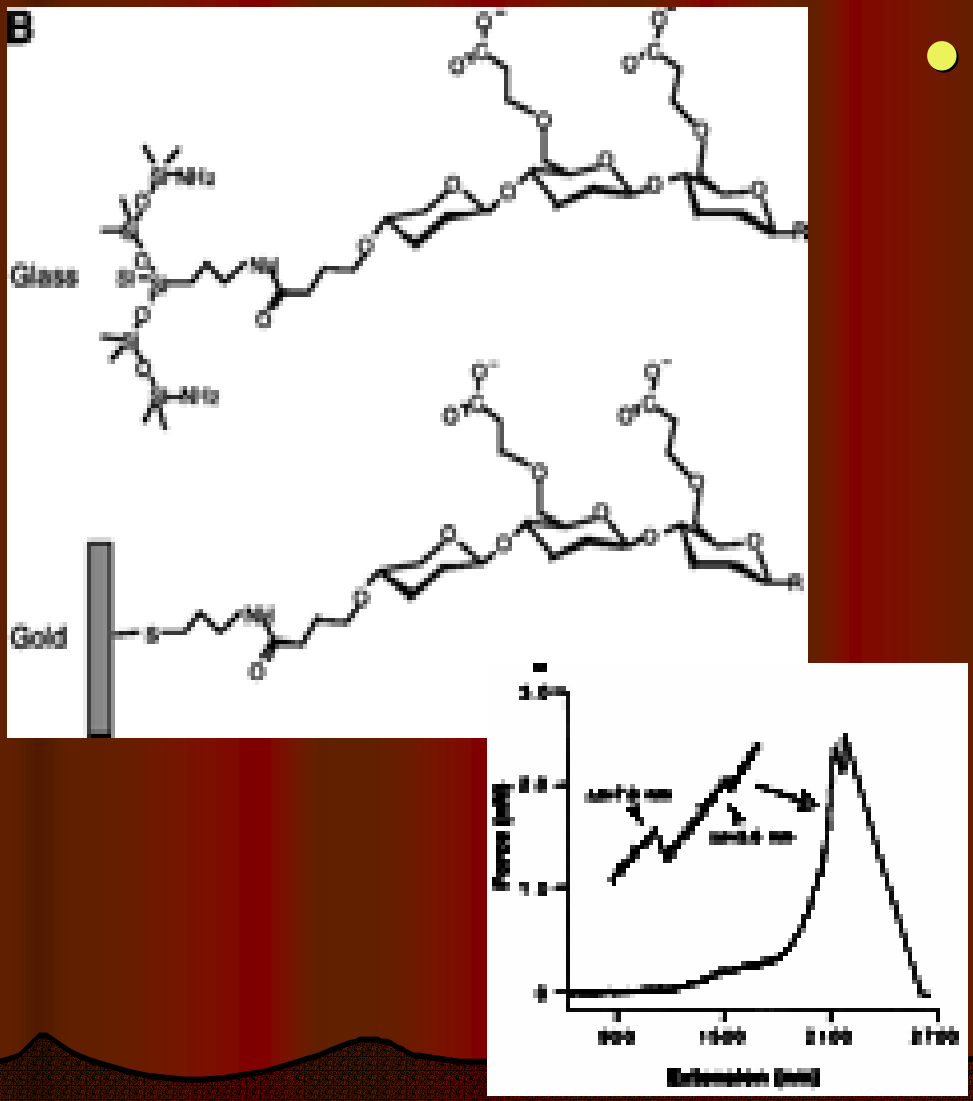
- **2.5 x 2.5 nm simultaneous topographic and friction image of highly oriented pyrolytic graphite (HOPG).**
- As the tip bumps into an atom it gets stuck behind it. The scanner continues to move and lateral force builds up until the tip slips past the atom and sticks behind the next one. This "stick-slip" behavior creates a characteristic sawtooth waveform in the friction image

How Strong Is a Covalent Bond?



- The rupture force of single covalent bonds under an external load was measured with an atomic force microscope (AFM).
- Single polysaccharide molecules were covalently anchored between a surface and an AFM tip and then stretched until they became detached.

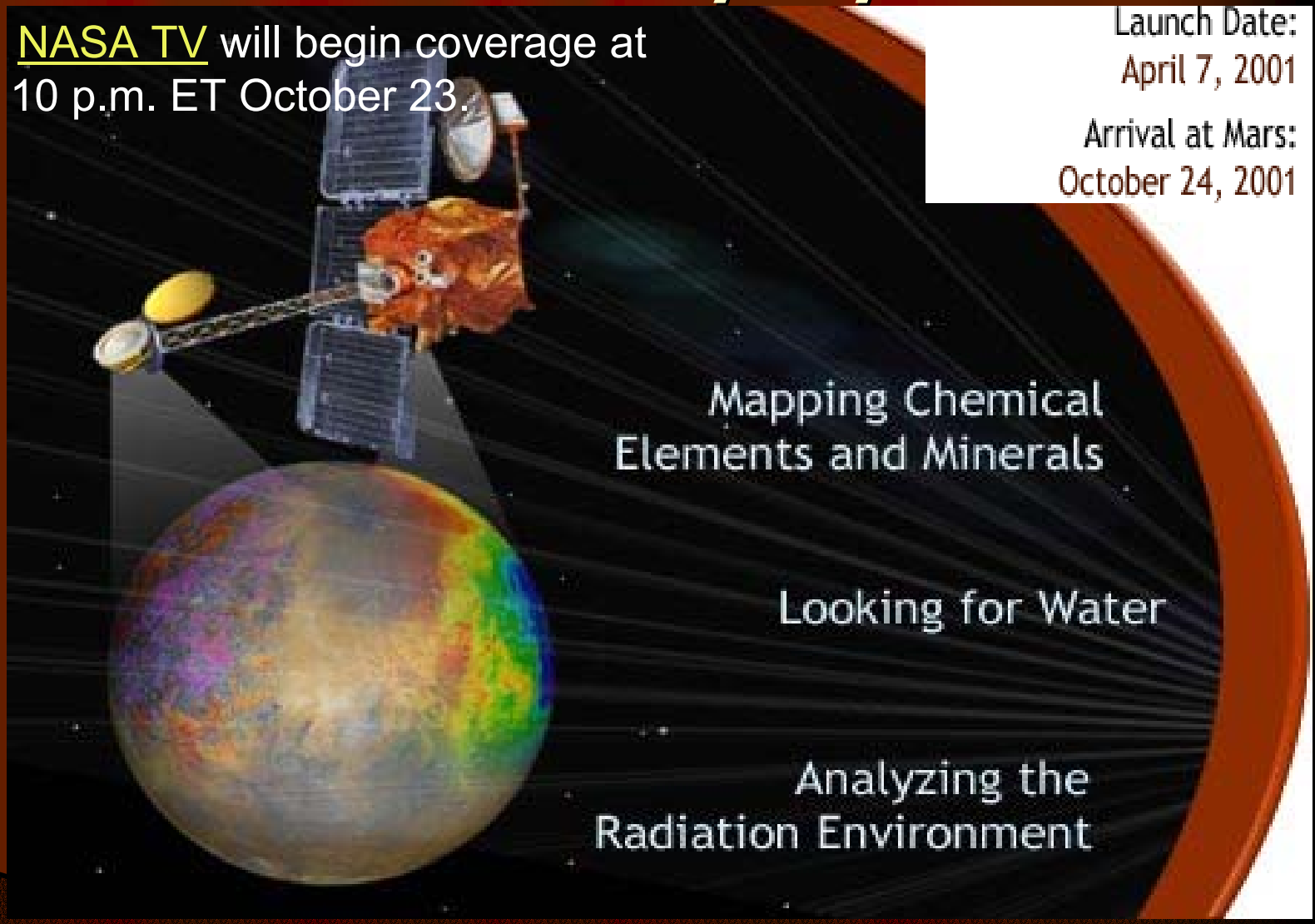
How Strong Is a Covalent Bond? (con'd)



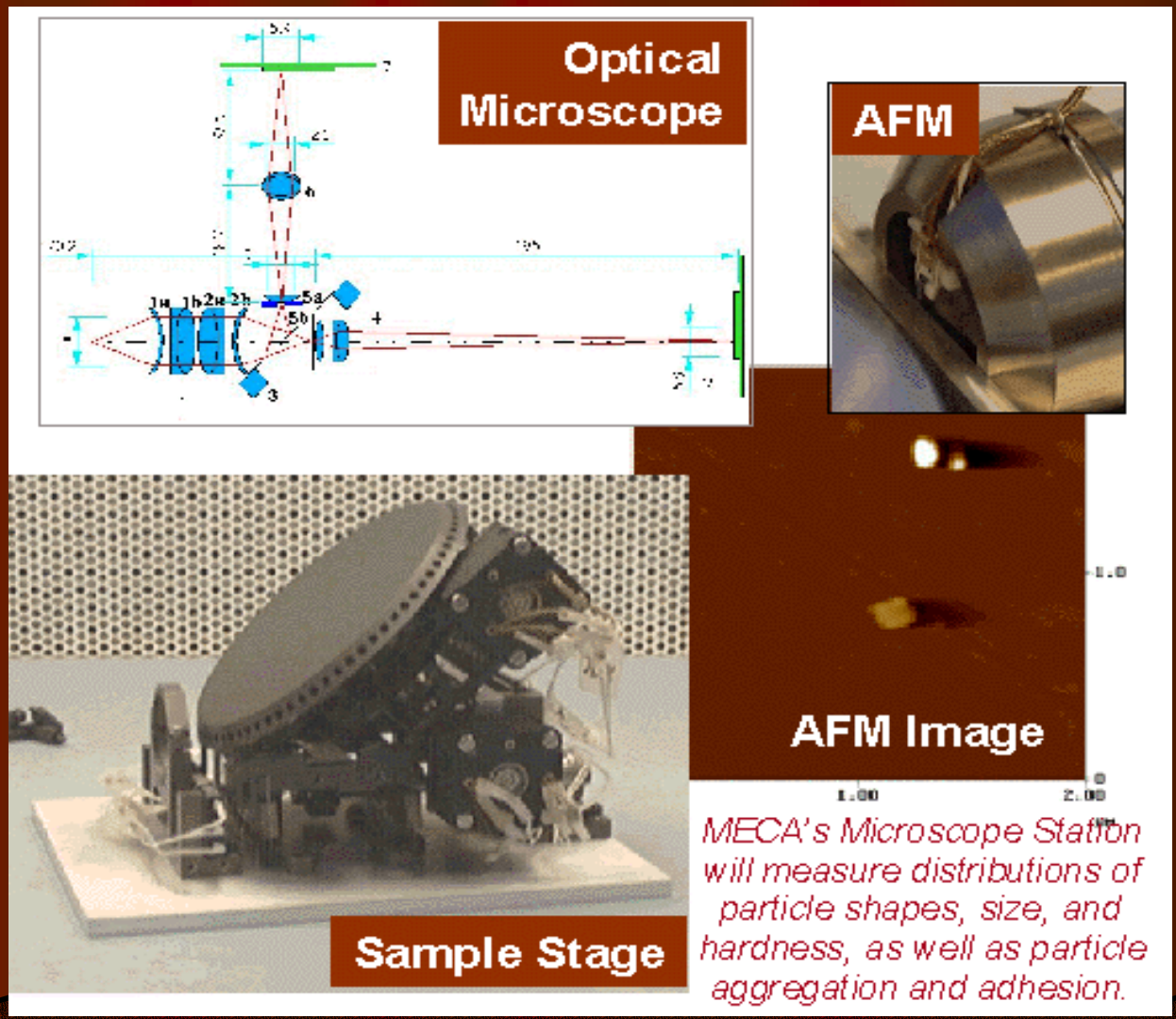
- By using different surface chemistries for the attachment, it was found that the silicon-carbon bond ruptured at 2.0 ± 0.3 nN, whereas the sulfur-gold anchor ruptured at 1.4 ± 0.3 nN at force-loading rates of 10 nN per second.

(Michel Grandbois *et al.*, *Science* **283**, 1721 (1999))

Latest Achievements
The 2001 Mars Odyssey Mission



Components of the Microscopy Station

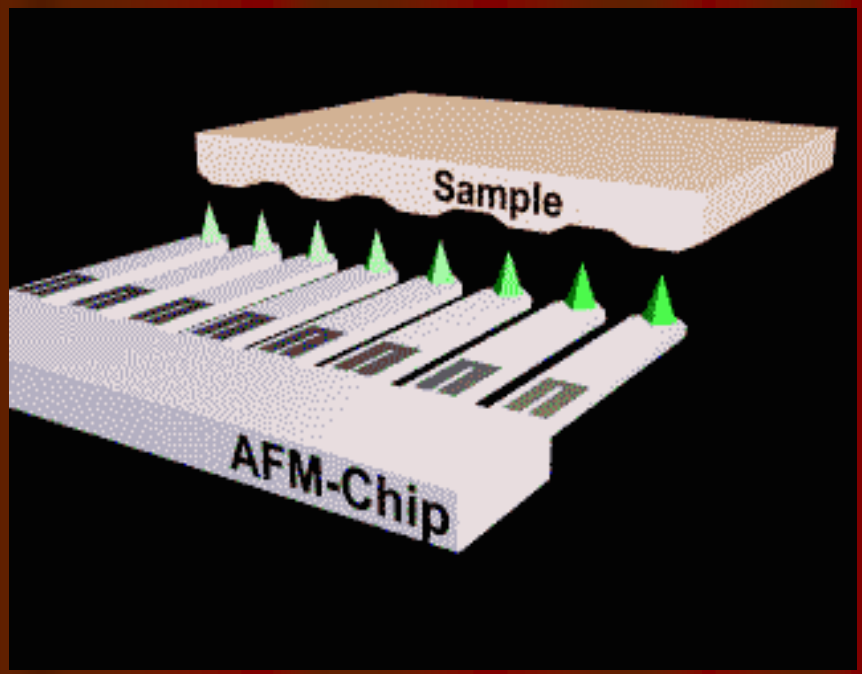


AFM on Mars Project

Swiss **Consortium** for design and development of the AFM for the Mars Surveyor 2001mission:

- Jet Propulsion Laboratory (JPL), Pasadena, USA: operational software development.
- Swiss Center for Electronics and Microtechnology (CSEM) Neuchâtel, Switzerland: development and production of diamond tips.
- Institute of Physics, (IFP) University of Basel, Switzerland: production and testing of AFM-electronic hardware for space applications

AFM-Chip with 8 cantilevers



- For redundancy the Mars-AFM is equipped with 8 addressable sensors and cantilevers on one chip. Only one at a time is used for imaging. If a tip is worn or dirty it can be broken off.
- First, the Martian soil is scooped by the robot arm and loaded on to a sample plate;
- then the sample wheel is rotated by 180 degrees and approached to within the scan range of the AFM;

Conclusions

- AFM can be a valuable tool for investigating a wide variety of structures and properties, providing information about
- Texture
- Appearance
- Parameters
- Distribution/composition
- Mechanical properties
- Dynamic interactions