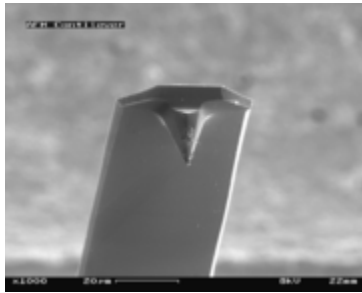


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What is an Atomic Force Microscope?

The Lego Scanning Force Microscope (LSPM) is a model of an Atomic Force Microscope (AFM), a very high resolution type of Scanning Probe Microscope (SPM). The AFM is one of the primary tools for imaging, measuring, and manipulating matter at the nanoscale level. The term “microscope” implies looking, while in fact the information is gathered by “feeling” the surface with a laser beam, or mechanical probe.

Nanotechnology provides technological tools to materials that are not visible to humans through any sort of visual method (i.e. your eye). We cannot use standard microscopes to look at the surface of a nano-sized material. The AFM touches or interacts with a surface and develops a 3D image.



“AFM is to optical microscopy as Braille is to sight”

The AFM has a cantilever arm, with a sharp tip (probe), which is used to scan the specimen surface. As the probe scans the surface, it sends data images that will form a topographical view of the surface, similar to maps you find of the earth’s surface, for a 3D image.

The Scanning Probe Microscope (SPM) concept is similar to radar; only instead of measuring sound reflections from the surface, we measure the surface through touch.

The atomic force microscope can be used to image and manipulate atoms and structures on a variety of surfaces. The atom at the point of the tip “senses” individual atoms on the underlying surface when it forms initial chemical bonds with each atom. These chemical interactions subtly alter the tips vibration frequency, which can be detected and mapped.

The advantage of an AFM is that unlike the scanning electron measurement, which provides a 2-dimensional projection, the AFM can produce a true 3-dimensional surface profile. Samples viewed with an AFM do not require any special treatments (such as metal/carbon coatings) that would irreversibly change or damage the sample.

Lego Scanning Probe Microscope (LSPM)

The LSPM is a scaled up model of a class of microscopes called Scanning Probe Microscopes; used to measure surfaces at the nano-level. The LSPM has a cantilever arm with a tip that interacts with the surface we wish to image. The surface sits on an XYZ platform that we can move in three dimensions. To scan the surface, the computer tells the table to move to a specific X- and Y- location. Once there, the table moves up in the Z- direction until the surface touches the tip of the cantilever arm. The table then stops, and the computer records the current location of the table. Once all the data points are collected, we have created a topographical view of the surface, similar to maps you find of the earth’s surface, that we can create a 3D image from.

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There are approximately 5,000 Lego's on the LSPM. It uses the Lego Mindstorms RCX brick to run the laser and determine whether the surface has been "touched".

The table is moved by servo motors that are controlled by the computer. The tip of the cantilever can be manufactured down to a single silicon atom. Carbon nanotubes can be used as tips.

The LSPM is made of Lego's on top of an aluminum frame. The 3D image is false-colored according to a pre-determined topographical method. Change in color designates a change in height.

If you took some silly putty and stretched it out, the surface imaged in the middle would look similar to the picture on the far right corner. (Next to the Kevin G. Hall for Metrology)