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ATOMIC FORCE MICROSCOPE

For my part of the final presentation, I chose to report on instruments that have been and continue to be utilized in the field of nanotechnology. To be more specific I chose the Atomic Force Microscope (AFM). The AFM was invented in 1986 as a collaboration between two prominent scientists; Calvin Quate and Christophe Gerber. The AFM was invented to overcome the limits of the AFM predecessor; the Scanning Tunneling Microscope (STM). For purposes of time and topic I will not discuss the STM in any great detail. The STM utilizes a tunneling current to produce images and therefore would only work on materials that could themselves conduct a current. The AFM does not have this limitation and is able to image materials such as polymers and biological materials. We will visit the AFM with more detail a little later. Let me take a moment to discuss the scientists involved in greater detail.

Calvin Quate is a Nevada local. He was born on December 7th, 1923 in Baker. Calvin spent his first few college years at the University of Utah where he earned a B.S. degree in Electrical Engineering. Calvin then spent the remainder of his student experience at Stanford University where he was able to earn his Ph.D. Calvin has worked in many different fields of science. For example he had his hands in acoustic amplifiers, acoustic semiconductors, and microwave amplification. In 1961 Calvin joined Stanford University as a Professor of Applied Physics and Electrical Engineering. He currently holds an engineering chair at Stanford and is a Senior Research Fellow at Xerox Palo Alto Research Center.

Christophe Gerber is currently the Director for Scientific Communication at the Institute of Physics at the University of Basel in Switzerland. Most of the information concerning his educational background was dismally absent. However his work has been internationally recognized; earning him multiple honorary degrees and awards. Christophe's current fields of study are wide and diverse; such topics as biomechanical sensors for AFM technology, chemical surfaces at nanoscale, magnetic resonance, and all things concerning nanomechanics. Christophe has contributed to the scientific community by authoring and co-authoring over one hundred scientific papers. Currently Christophe is a fellow of the American Physics Society and a fellow of the IOP Institute of Physics where his portfolio contains 37 patents and patent publications.

I will now take a moment to explain, in simple layman terms, how an AFM operates. The AFM is a very high-resolution probe microscope capable of imaging objects that reside in the realm of nanoscale. Nanoscale is a system of measurement with a factor of 10^{-9} meters and smaller. Typically we can say that nanoscale exists between one and one hundred nanometers. The AFM consists of a cantilever, a laser and a photodiode. On the end of the cantilever a sharp and miniscule tip has been attached that is typically formed out of silicon.

The cantilever is lowed onto a sample surface where the silicon tip creates a simple pressure. As the specimen is moved under the tip, a force is created that will cause the cantilever to deflect. During the operation process, a laser has been focused on the top of the cantilever. The laser spot is then reflected into a light detector called a photodiode. As the cantilever is deflected by the surface of the sample, the laser light will change position on the photodiode creating data points based on the amount of deflection. These data points are then collected and interpreted by an AFM specific software that will produce an accurate image.

The AFM has many other types of imaging processes that can be utilized. The mode described above is called Contact mode and is the most widely used imaging process. There is a Non-Contact mode as well. In this mode the tip of the cantilever will never actually make contact with the sample. Instead the cantilever is oscillated at a frequency above its own resonant frequency. When the tip is lowered closer to the sample the resonant frequency of the cantilever will decrease allowing specific measurements to be made that become a useable image. The AFM has also been designed to use a Tapping mode. During this mode the cantilever is oscillated up and down near its own resonance frequency. As the tip is lowered to the sample the amplitude of the oscillation will decrease allowing the production of an image based on this change in oscillation.

The AFM has a few more uses that I will not cover in this report. If you are interested I highly recommend doing some research of your own. One of the most interesting facts that I came across is the ties the AFM has to the state of Utah. One of the founding scientists was a graduate of the University of Utah. Most of the students at Salt Lake Community College do not realize that an Atomic Force Microscope is available for use on campus. The AFM is located in the basement of the SI Building and is already being utilized by SLCC students. If you're interested, I recommend contacting Dr. Wesley Sanders; he is a chemistry Ph.D. who is the caretaker of SLCC's AFM.

Recourses

http://en.wikipedia.org/wiki/Atomic_force_microscopy

http://en.wikipedia.org/wiki/Calvin_Quate

http://www.ieeeghn.org/wiki/index.php/Calvin_F._Quate

http://en.wikipedia.org/wiki/Christoph_Gerber

http://www.physik.unibas.ch/dept/pages/de/personnel/gerber.htm

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