Precise STM determination of the Young's Modulus of single CdS nanoparticles.

The importance of precise measurement of the mechanical properties of matter is due to the fact that the elastic constants are the second derivatives of the interatomic potential. Ideally, the measruement of elastic constants on the atomic scale, can reveal this potential.

We demonstrate the precise STM evaluation of the Young's modulus (E) of CdS NP's of different sizes. I-Z spectra on a clean gold surface (with a known E) gave the tip radius. I-Z spectra on the NP's (diameters of 3, 6 and 7.5 nm) using the same tip, gave E = 52.5% , 75.7% and 82.7% of the bulk value, respectively.

The compressive surface stress f generates a hydrostatic pressure of $2f/r$ (Laplace's law) which sets up an increasing radial strain. calculation using third order elastic constants gives a reduction of E which scales linearly with 1/r. It agrees with the experimental results to within 5%.

Unlike the macroscopic methods of elasticity measurement, this method gives the freedom to study nanometer scale mechanical properties directly and locally. Performing similar studies on an individual molecule is expected to provide much local and specific information on a whole or parts of an adsorbed molecule to provide chemical contrast on the nm scale.