

The increasing interest in Nanotechnology arises from the fact that nanoscale processes and properties lie in between the realm of atoms and that of the macroscale. Research in this area has led to the discovery of graphene, fullerene and nanotube molecules with true nanoscale dimensions, artificial atoms such as quantum dots and the understanding of processes in the domain of molecular physics leading to fields ranging from molecular electronics, to the control of enzymatic and catalytic processes which have made possible, amongst others, the advent of genomics and nanofabrication with biological molecules [1].

Imaging with nanoscale resolution has become routine practice with the use of scanning probe techniques. Nevertheless, quantification of material properties and processes has been hampered by the complexity of the tip-surface interaction and the dependency of the dynamics on operational parameters. Here, we propose a framework for the quantification of the coefficients of viscoelasticity, surface energy, surface energy hysteresis and elastic modulus. Quantification of these parameters in the nanoscale will provide a firm ground to the understanding and modelling of tribology and nanoscale sciences with true nanoscale resolution [2-3].

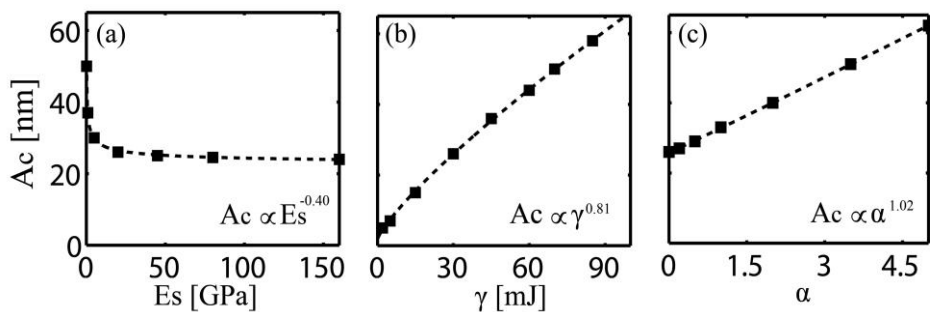


FIG. 3 Simulations. Relationships between the critical amplitude to reach mechanical contact A_c (a) elastic modulus of the sample E_s , (b) surface energy γ and (c) surface energy hysteresis α [1].

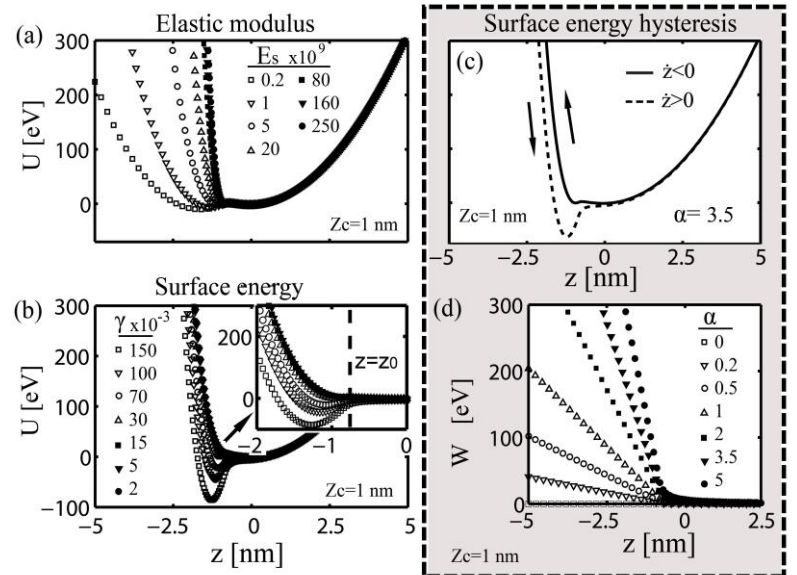


FIG. 2 Behaviour of the perturbed potential U with variations in (a) elastic modulus of the sample E_s and (b) surface energy γ . (c) Double potential resulting from surface energy hysteresis. The work done by the tip against surface energy hysteresis for several values of α is shown in (d). Here, the equilibrium separation is $z_c = 1$ nm and the instantaneous distance is z . These figures qualitatively show that as the elastic modulus of the sample increases and as the surface energy and surface energy hysteresis decrease, the attractive regime is inhibited [1].

Viscoelasticity does not affect the average force

$$\langle F_\eta \rangle = -\eta R^{1/2} \int_{t=-t_0/2}^{t=t_0/2} \delta^{1/2} \frac{\partial \delta}{\partial t} dt = -\eta R^{1/2} \int_{t=-t_0/2}^{t=t_0/2} \delta^{1/2} \frac{d\delta}{dt} dt = 0$$

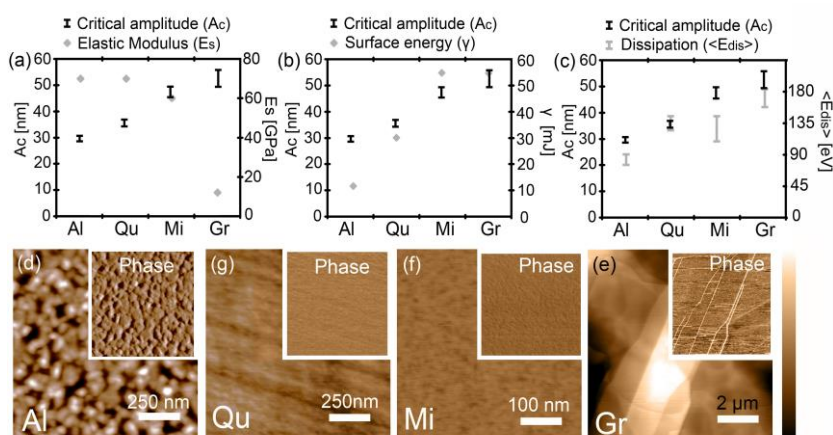


FIG. 2 (Top) Experimental values of A_c for Aluminium, Quartz, Mica and Graphite samples versus (a) the tabulated elastic modulus of the samples, (b) the surface energy and (c) the experimental values of energy dissipation per cycle $\langle E_{dis} \rangle$. Topographic and phase (insets) images of the samples are shown in (d) to (e). **FIG. 3 (Right)** Experimental (continuous lines) $\langle E_{dis} \rangle$ versus A/A_0 curves obtained on (a) Aluminium, (b) Quartz, (c) Mica and (d) Graphite samples and using (Fig. 2). Simulations are shown in dashed gray lines [1].

