# ADHESION HYSTERESIS AND CAPILLARY INTERACTIONS IN DYNAMIC ATOMIC FORCE MICROSCOPY

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**Resumen:**

Dissipation spectroscopy in amplitude-modulation AFM (AM-AFM), based on the analysis of the dissipated power as a function of the cantilever oscillation amplitude, has been shown to be a powerful tool to identify specific energy dissipation processes at the nanoscale [1]. As a general approach, power dissipation in AM-AFM is naturally considered synonymous of energy dissipated per cycle. Assuming that the dissipation takes place in each oscillation cycle, it would be proportional to the oscillation frequency, $\nu_0$, i.e. $P_{dis}=\Delta E\nu_0$, being $\Delta E$ the energy dissipated in the contact process. In striking contrast to this apparently natural argument, we show that the time-averaged dissipated power is not always proportional to $\Delta E$ due to a beating phenomenon where the interaction is occasionally dissipative [2,3].

In air ambient condition, when the tip approaches the sample, water condensation from the humidity can induce the formation of a nanometer-sized water bridge and dissipation can be strongly influenced by capillary forces [2]. Even in vacuum, intrinsic mechanical instabilities may lead to the formation of an atomic-scale connective neck [4]. With the help of numerical simulations, dissipation contrast in AM-AFM is shown to be a result of a non-trivial interplay between the energy dissipated in each rupture process and the bi-stable motion of the cantilever. In the repulsive regime (see Fig. 1), the dissipated power is approximately constant and independent of the amplitude as expected. Working in this regime, and for large relative humidity, energy dissipation images in air can be regarded as surface hydrophobicity maps [2]. In contrast, in the attractive regime, after the contact process, the cantilever, which has lost energy, will not reach the same amplitude as before the contact, and the tip may not hit the sample surface during the next swings. The power dissipation is then lower than expected.

**Referencias:**

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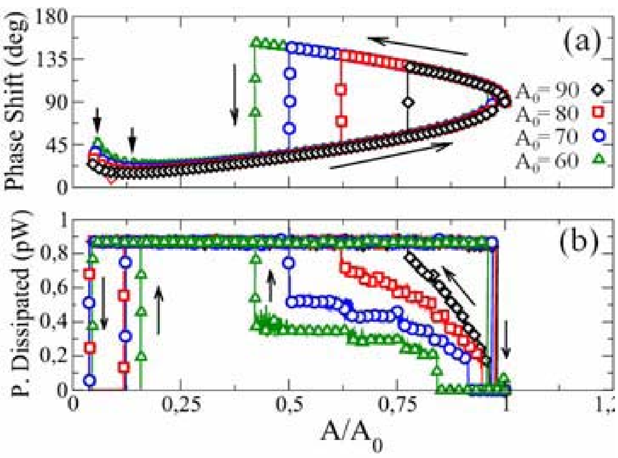


Figure 1: Simulated phase (**a**) and power dissipated (**b**) vs normalized amplitude (After Ref. [2]).