Measurement of adsorbed liquid films using Dynamic Force Spectroscopy

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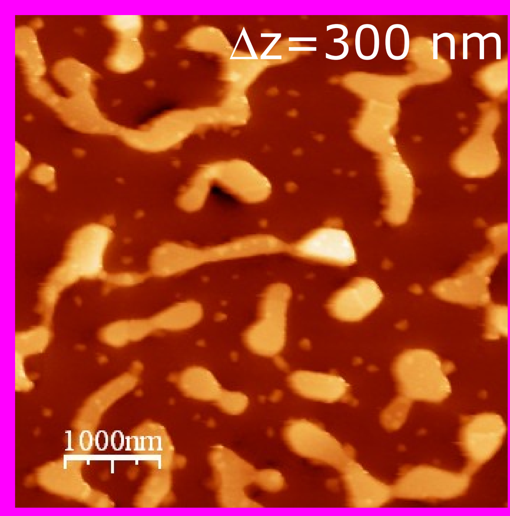
Introduction

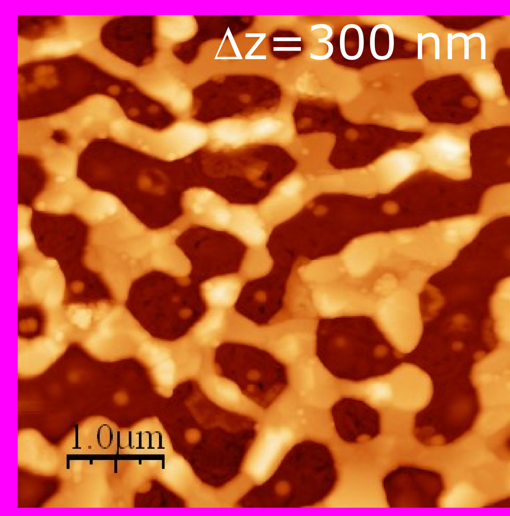
Tip-sample interaction is measured in ambient conditions on gold and glass at different relative humidity. As compared to other spectroscopic experiments, very small oscillation amplitudes (<100pm) are used to keep the tip-sample system in the linear regime, this simplifies data processing and data interpretation. Very high signal to noise ratio is obtained in spite of the small oscillation amplitude. The force, the force gradient and the quality factor are determined simultaneously as a function of tip-sample distance. In the non-contact regime of the interaction, essentially no force and no variation of the quality factor is measured. Until the jump to contact point is reached, the force gradient perfectly follows the relation predicted by pure Van der Waals interaction. Since force and force gradient are measured simultaneously, the tip-sample position can be determined either from the force vs. distance (FvsD) curve, or from the pole of the Van der Waals interaction.

The samples

The samples used in this experiment were gold islands on to a glass cover substrate. Two samples were studied sample E and sample J



Sample E



Sample J

The method

Data are acquired at fixed lateral position as "interaction" images, 3-D mode.

Simultaneous measurements of normal force, oscillation amplitude and phase.

Very small oscillation amplitudes (<100 pm) thermal noise, system in the linear regime.

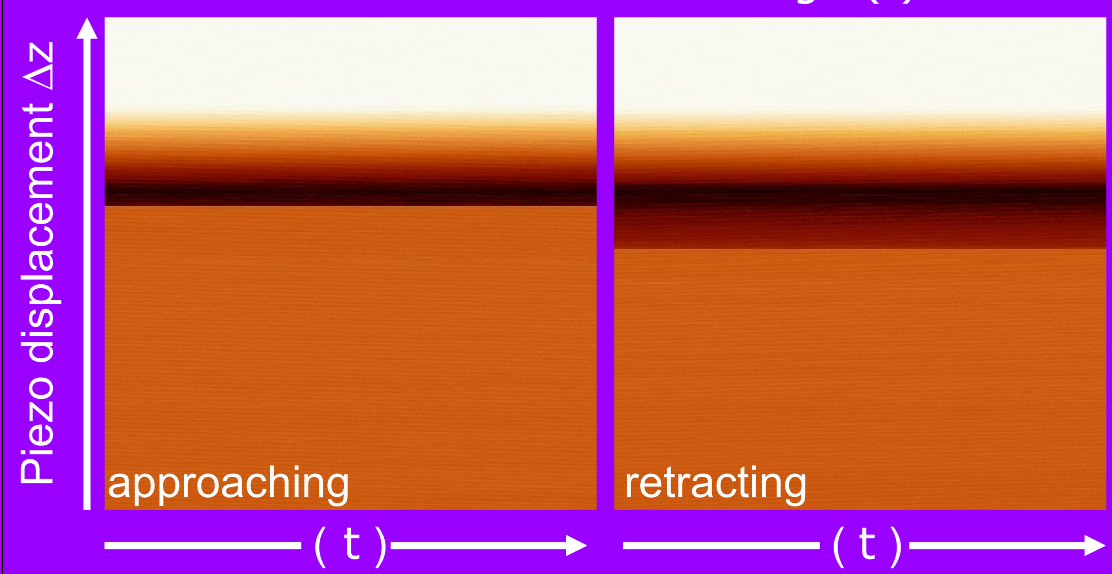
External feedback in the normal force to control the cantilever deflection and minimize the tip damage.

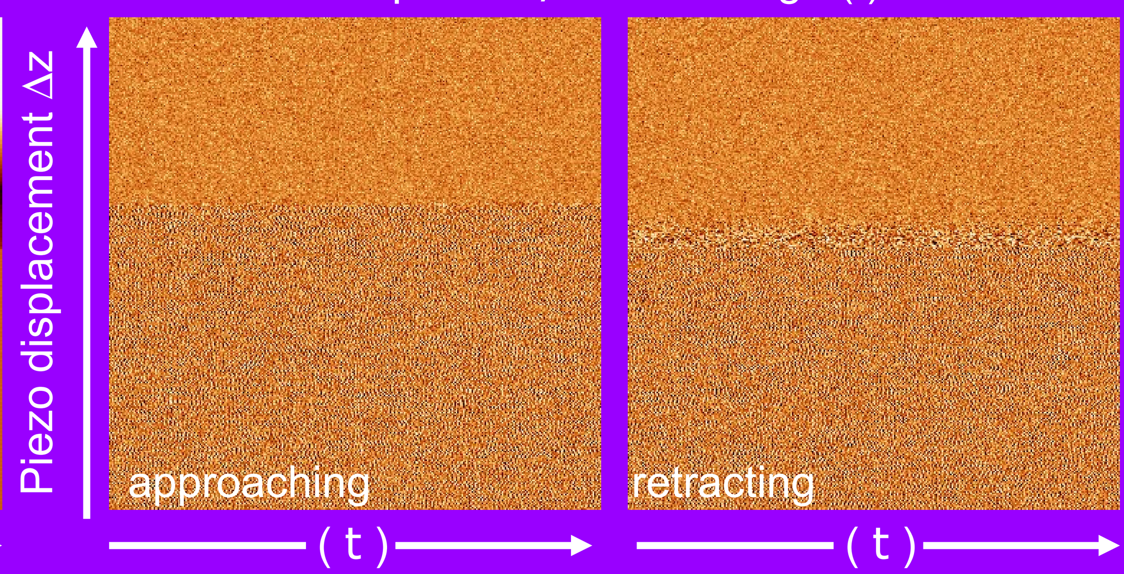
Data processing with WSXM and Mathematica code.

Experimental

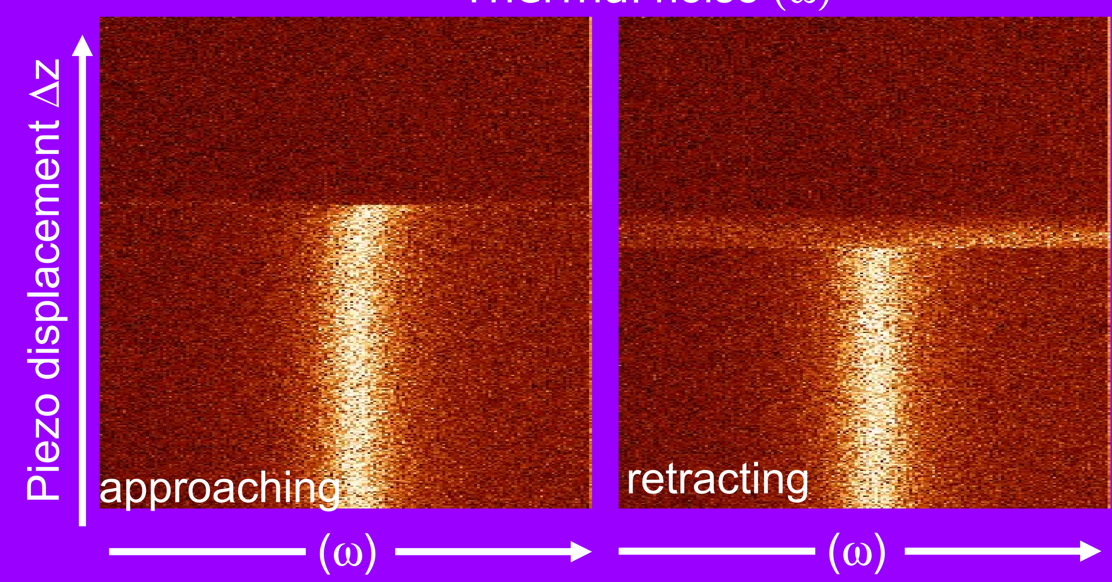
Dynamic Force Spectroscopy 3-D Modes

Sample E, Glass, relative humidity 2%





1-D FFT



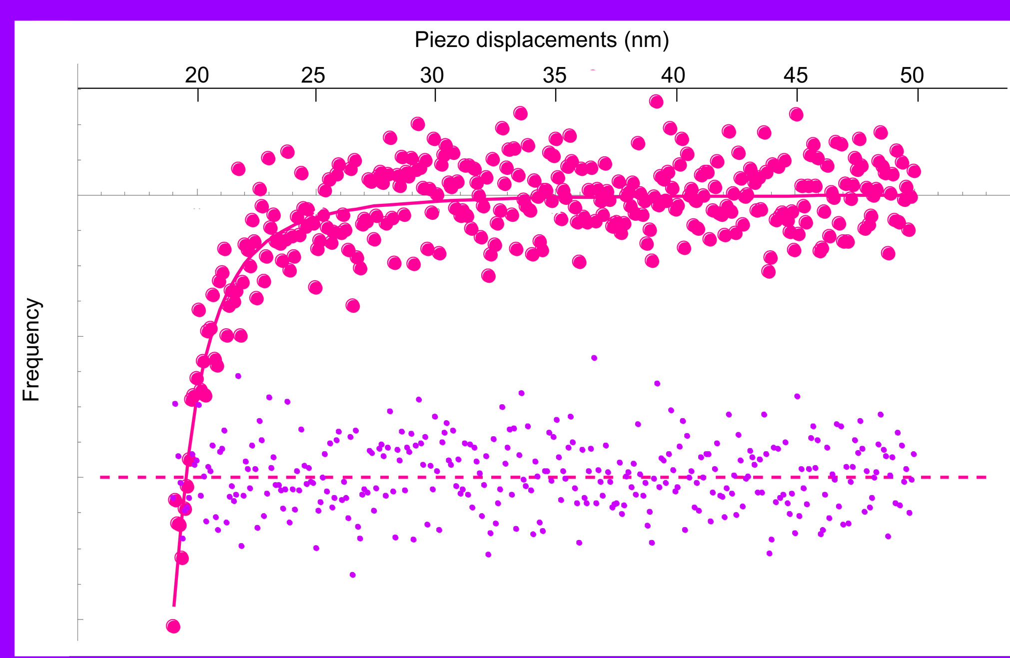
Processing with Mathematica

- **Adhesion force**
- **Jump to contact**
- **Surface position**

Liquid layer

Force gradient ω (d) curves
Van der Waals interaction

$$\Delta\omega = -\frac{A \cdot R}{3 \cdot c_{lever}(d-d_0)^3}$$

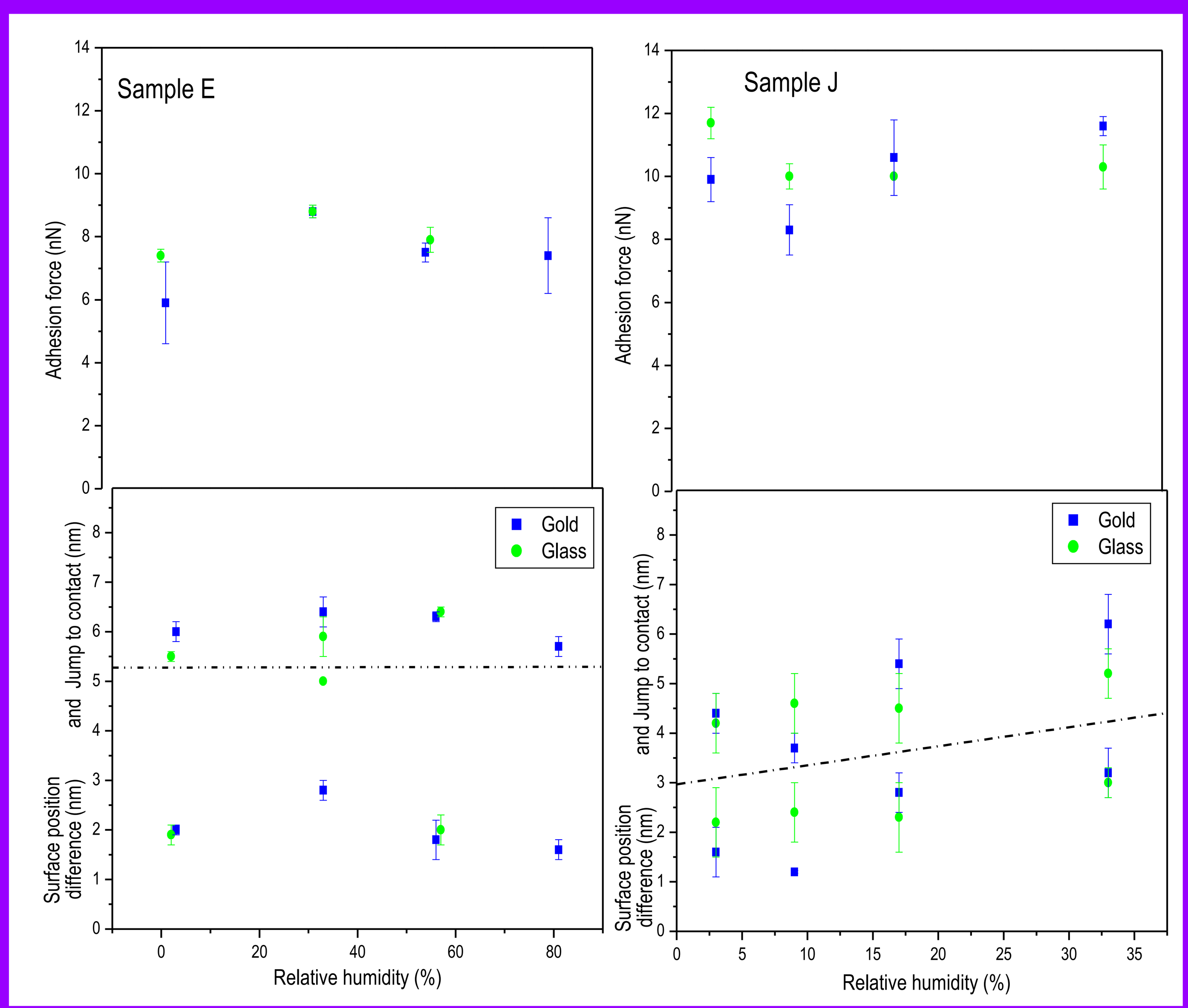


Fitting procedure

- **Pole VdW interaction**
- **Tip radius**

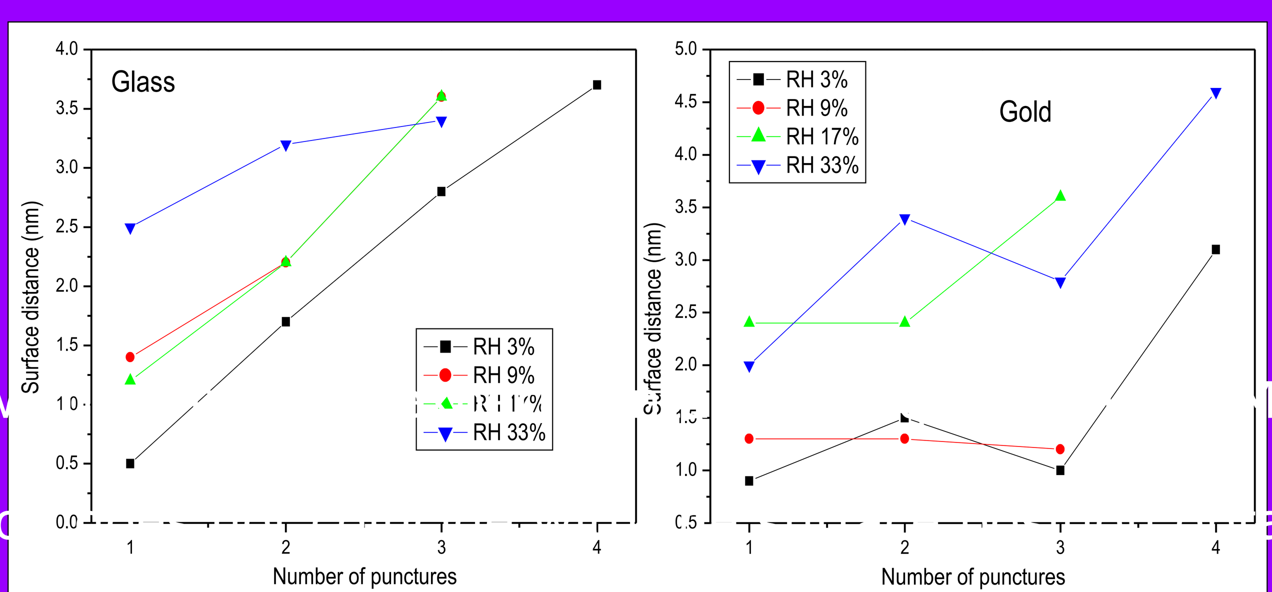
Results

Adhesion force does not present any trend with the humidity



Large jumps to contact 4-6 nm even at low humidity

In general, "light" increase of the jump to contact and surface position difference with the humidity for sample J



The changes in the jump to contact and surface position difference are more pronounced as a function of the number of punctures than with the humidity or the material.

Conclusions

new ... at very small oscillation amplitudes (<100pm)

actio... ained from the force data, we interpret that the force data would detect the "hard" surface (m

o contact (4-6 nm even at low humidity, indicating the importance

ew experimental technique with samples that present two materials

f hydrophobicity.