ROUGNESS AND FRACTAL DIMENSION MEASUREMENTS IN THE NANOSCALE BY SFM.

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SFM allows an simultaneously measure of the most important tribological properties: topography, normal force and lateral force. Related to the precise description of topography, the surface roughness is a fundamental quantity that determines the tribological behavior [1,2] of surfaces, even though the precise way in which this occurs is still under discussion. An important issue in this context from the experimental as well as from the theoretical point of view is the question: down to which scale is surface roughness important, and which scale is the most relevant one for tribology. In this work, we study how surface roughness can be correctly measured from the several micrometer scale down to the nanometer scale with Scanning Force Microscopy (SFM) techniques.

SFM is used to characterize the roughness at different length scales with a simple model for the surface roughness of a statistically rough surface by means of the analisis of power spectral density curves obtained from SFM topographical images. This issue has been addressed previosly in the literature[3,4], but we believe that but some important aspects have not yet been discussed [5]. Since data analysis is based on the evaluation of log-log plots it is important to acquired a large number of image points in order to be able to cover several length scales. We believe that at least 3 order of magnitudes should be covered which implies a at least one million data points for an image. A sufficiently high number of image points not only allows to cover a larger length scale of measured surface roughness, in addition the statistical significance of the measured surface roughness increases.

A fundamental issue is related to the perfect acquisition of topographic data. Roughness analysis requires very high quality topographic data. In this context it is fundamental to note that successful data processing and data interpretation may be severely limited by a series of technical issues. Since each data point should be "correct" scanning speed and settling time have to be selected so that the feedback loop is capable of adjusting the correct topographic height at each image point. A fundamental first step for roughness analysis is the acquisition of a topography image free of any noise. In particular, spikes due to lack of response of the feedback loop or oscillation of the feedback system, often present in SFM images, will severely degrade the quality of SFM data. Optimization of feedback parameters (fast enough but no oscillation) and scanning speed was crucial. In addition, thermal drift and instrumental noise will additionally degrade data analyis.

In this work we will present and discuss nanoscale surface roughness of differents samples hard samples (steel, sapphire and hard metal balls) as well as soft samples like polymers (P3OT poly-3-octylthiphene).

References:

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Figures:

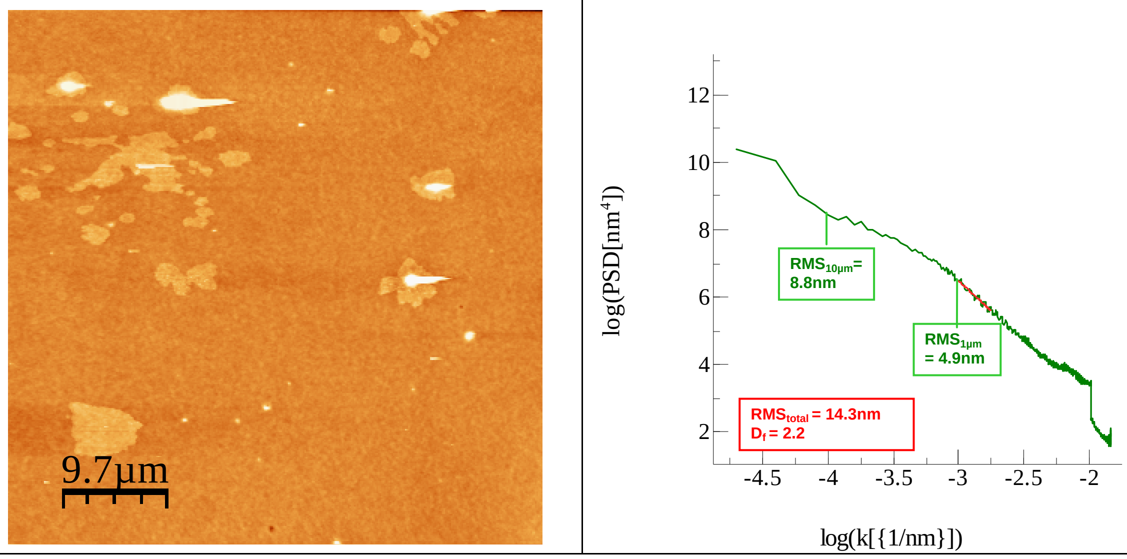

Fig 1. Topography image of P3OT (left) and its power spectral density curve(right). RMS at different scales and fractal dimension (D_f) are shown.

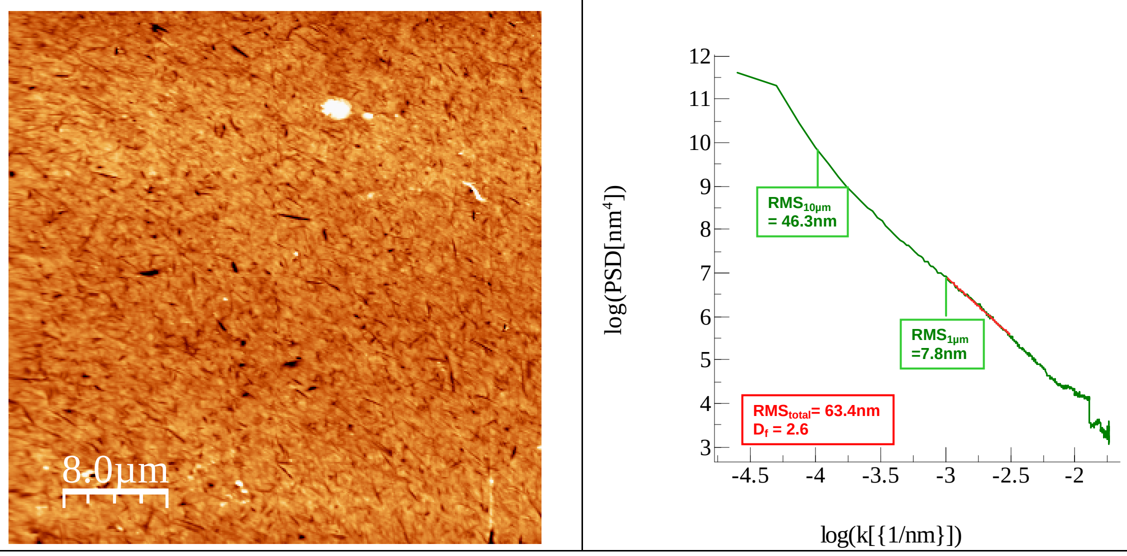

Fig 2. Topography image of Saphire ball surface (left) and its power spectral density curve (right). RMS at different scales and fractal dimension (D_f) are shown.