3D-AFM imaging of the liquid-solid interface at the nanometric scale

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Solid-liquid interfaces are of great abundance since they occur whenever a solid meets a liquid. Investigating these interfaces is of great importance for the fields of science, medicine and technology. But, regardless of their importance, there are very few techniques to study these interfaces at the atomic and molecular scale. However, a new technique was recently developed for interfacial characterization: the 3D-Atomic Force Microscopy (Figure 1a) [1,2]. In general, AFM is used for surface characterization where a 2D topographical image of the surface is generated. Also, AFM can be used in 1D as force spectroscopy where point-by-point force vs z-distance curves are measured. 3D-AFM is a combination between these two techniques where a 3D image of the phenomena occurring above the surface, i.e. the interface, is generated. In this work, a 3D – AFM system is implemented in a conventional 2D-AFM apparatus (Park System's NX10) and the study is focused on the characterization of gold surfaces functionalized with thiol polymers for tribological and biological applications.
Four samples were used: pure gold, pure Poly(Acrylic Acid) PAA, pure Poly(Ethylene Glycol) PEG, and 50/50 PAA/PEO (figure 1a). We measured these samples in pure water and in a 0.01M PBS solution. The shifts in the frequency Δf recorded during the 3D-AFM scan were used in a Python program to create a 2D (xz) colour coded cross-sectional image of the scanned samples (Figure 1b). Our first experiments tend to show that this 3D-AFM method is appropriate to visualize the difference in behaviour between the samples caused by different polymer chain-tip interactions during the measurement. Our future work consists of generating force/distance curves using the Δf curves and the Sader-Jarvis equation. Then a 3D force map of the sample can be created by combining the several 2D (xz) cross-sectional force maps created.

References

[1] T. Fukuma, R. Garcia, ACS Nano, 12 (2018) 11785-11797
[2] H. Asakawa, S. Yoshioka, K. Nishimura, T. Fukuma, ACS Nano, 6 (2012) 9013-9020

Figures

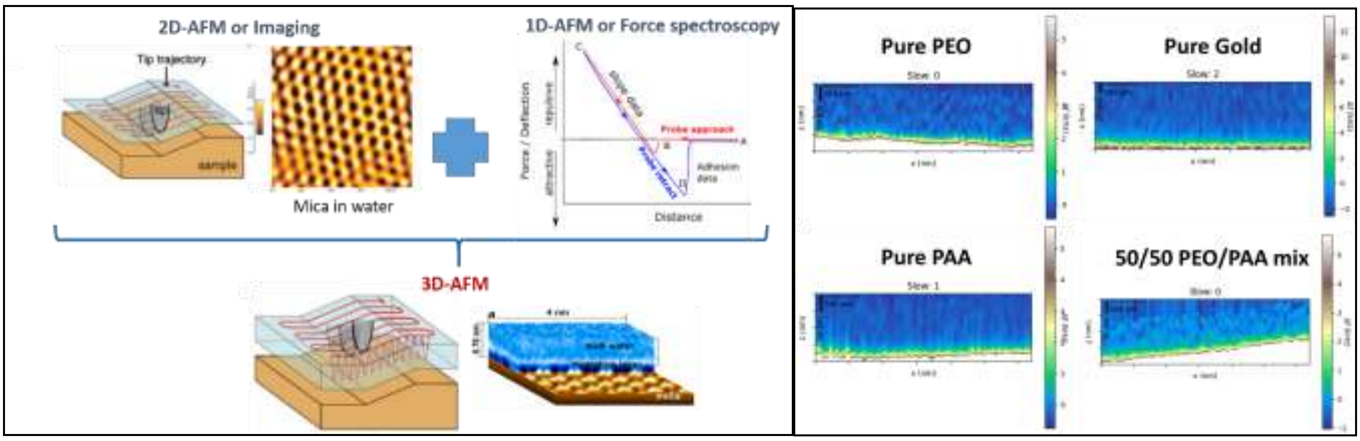

Figure 1. Representation 3D-AFM (left image) and 2D (xz) cross-sectional images of the pure PEO and the mixed PAA/PEO samples scanned in a 0.01M PBS solution by 3D-AFM (right image)