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Analysis of piezoresponse force microscopy signals obtained during force-distance curves

Piezoresponse force microscopy (PFM) is a unique technique that enables the study of ferroelectric properties at the nanoscale level. Scientific advancements and the proposal of new ferroelectric systems have encouraged the development of several variations of PFM. Specifically, for ferroelectrics with poor mechanical properties, hybrid-PFM (H-PFM) has been introduced.

Within force-distance curves, a time window of mechanical contact exists between the tip and the sample. In H-PFM, this time window can be leveraged to apply the AC bias used for PFM measurements, thereby avoiding the influence of lateral forces present in conventional contact PFM. Despite the utility of H-PFM in studying ferroelectric properties in mechanically soft samples, a thorough investigation of the H-PFM mode has not been conducted. The objective of this work is to analyze the amplitude and phase PFM signals during force-distance curves to gain a better understanding of the PFM results.

In this work, the amplitude and phase PFM signals will be analyzed during force-distance curves obtained on a periodically polarized sample of LiNbO3. The study will be divided into two parts: before contact and during tip-sample contact, in order to establish the optimal conditions for obtaining reliable PFM characterizations.

A developed protocol has determined that the PFM signals obtained before the contact of the force-distance curves can be utilized to discern the influence of electrostatic artifacts during PFM characterizations. Meanwhile, a procedure for obtaining the best amplitude and phase PFM images has been established during the contact in a force-distance curve.

Keywords

AFM, PFM, Force-distance curves

Reference

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Author approval

I confirm

Author will attend

I confirm

Authors: MURILLO BRACAMONTES, Eduardo (Centro de Nanociencias y Nanotecnología UNAM); Dr GERVACIO, J. J. (Facultad de Ciencias Físico Matemáticas, Benemérita Universidad Autónoma de Puebla); CRUZ, M. P. (Centro de Nanociencias y Nanotecnología UNAM); Dr HERNANDEZ-MARIN, S.T. (Facultad de Ciencias Físico Matemáticas, Benemérita Universidad Autónoma de Puebla)

Presenter: MURILLO BRACAMONTES, Eduardo (Centro de Nanociencias y Nanotecnología UNAM)

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