



School of Nano Science (IPM)



Condensed Matter & Statistical  
Physics Group (IPM)

## Weekly Webinar

### Quantification of viscoelastic properties using contact resonance atomic force microscopy with U-shaped probes

Speaker: **Dr. Ehsan Rezaei**

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Contact resonance atomic force microscope (CR-AFM) methods are relatively new measurement techniques used to quantify the elastic and viscoelastic properties of numerous materials such as polymers, elastomers, metallic glasses, asphalt, and biological materials. More recently, AFM thermalevers have been developed to allow local heating of samples, although they have much more complex resonances. These U-shaped probes have one distinct advantage over rectangular AFM probes, in that specific modes allow the in-plane and out-of-plane tip-sample motion to be excited independently at the same location using a Lorentz force excitation. In this technique, vibration models of the probe and tip-sample contact models are used to determine the sample properties from the frequency behavior. A simplified analytical model of the U-shaped probe based on two beams clamped at one end and connected with a perpendicular cross beam at the other end is described here. This three-beam model (TBM) for the case in which the tip is not in contact with the sample (the free case) is first solved and the results are in good agreement with the finite element model (FEM) solution. After that, the sample contact as three orthogonal Kelvin-Voigt elements are included in the model, and the resonant frequencies and peak widths are well agreed with the FEM solution. Finally, the contact resonant peaks acquired from the experiments are analyzed to obtain the stiffness and damping of the in-plane and out-of-plane of polymers, and in particular, the loss tangent of several polymers including high-density polyethylene and polystyrene are quantified. We expect the results of this study to allow reliable measurements of the viscoelastic properties of materials with spatial resolution on the order of tens of nanometers.

**Wednesday, 21 October 2020 (۳۰ مهر ۱۳۹۹), 14:00-15:00**

Virtual Meeting Room (please log in as a guest):

<https://www.skyroom.online/ch/schoolofphysics/school-of-nano-science>

