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Deformation rate dependence of atomic force microscope based nano-mechanical measurements

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The mechanical properties and extent of sub-micron features in polymer blends and composites are of interest due to their influence on macroscopic material performance. Atomic force microscopy is a natural tool to study these materials due to its high resolution and its ability to directly probe the mechanical properties of the sample. Over the past two decades, AFM based mechanical property mapping techniques have evolved from slow force volume to much faster dynamic measurements using TappingMode and contact resonance. Recently, real-time control of the peak force of the tip-sample interaction has led to a fundamental change in AFM imaging, providing force-volume-like quantitative mapping of mechanical properties at reasonable scan rates and very high resolution, even on soft materials. During material property mapping, the time scale of tip-sample interaction now spans from microseconds to seconds, tip sample forces can be controlled from piconewtons to micronewtons, and spatial resolution can reach sub-nanometer. This has enabled AFM to become a unique mechanical measurement tool having large dynamic range (1 kPa to over 300 GPa in elastic modulus) with the flexibility to integrate with other physical property characterization techniques. In addition to elastic and plastic properties, researchers have begun to take advantage of the wide range of deformation rates accessible to AFM in order to study time dependent properties of materials such as viscoelasticity. More traditional measurements with indentation DMA are usually limited in frequency to a few 100 Hz and have limited spatial resolution. In contrast, AFM measurements can extend from less than 1 Hz to kHz and beyond while retaining the high resolution needed to see the details in distribution of properties near domain boundaries in nanocomposites and thin films. This presentation will review this recent progress, providing examples that demonstrate the dynamic range of the measurements, and the speed and resolution with which they were obtained. Additionally, the effect of time dependent material properties on the measurements will be discussed.

Biography

Samuel LESKO is currently working as an Applications Manager at EMEA & Latin America | Bruker Nano Surfaces Division

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