Quantifying Nanomechanical properties with Simultaneous AM-FM and tanδ Imaging

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Frequency-Modulated (FM) is a powerful, quantitative technique for mapping interaction forces between an oscillating tip and sample. Since FM-AFM typically requires the use of three feedback loops, one ongoing challenge has been stable and cross-talk free operation. Amplitude-modulated Atomic Force Microscopy (AM-AFM), also known as tapping mode, is a proven, reliable and gentle imaging method with wide spread applications. Recently, the phase signal of the first resonant mode has been recast in terms of the tip-sample loss tangent.[1] This allows quantitative imaging of a response term that includes both the dissipated and stored energy of the tip sample interaction. Combining AM and FM imaging allows reaping the benefits of both techniques.[2] Because the feedback loops are decoupled, operation is more robust and simple than conventional FM imaging. In this mode, the topographic feedback is based on the AM signal of the first cantilever resonance while the second resonance drive is frequency modulated. The FM image returns a quantitative value of the frequency shift that in turn depends on the sample stiffness and can be applied to a variety of physical models. We will present results on a wide variety of materials as well as discussing quantitative separation of the elastic and dissipative components of the tip-sample interactions.[3]

Figure 1 shows one example, a cryo-microtomed, cross-sectioned area of a coffee bag packaging material. The loss tangent image on the left clearly shows the highly lossy "tie" layers connecting the low-loss metal layer with two vapor-barrier polymer layers. The simultaneously acquired FM image on the right shows the relative stiffness of the five layers, with the metal layer being the stiffest and the tie layers the softest.

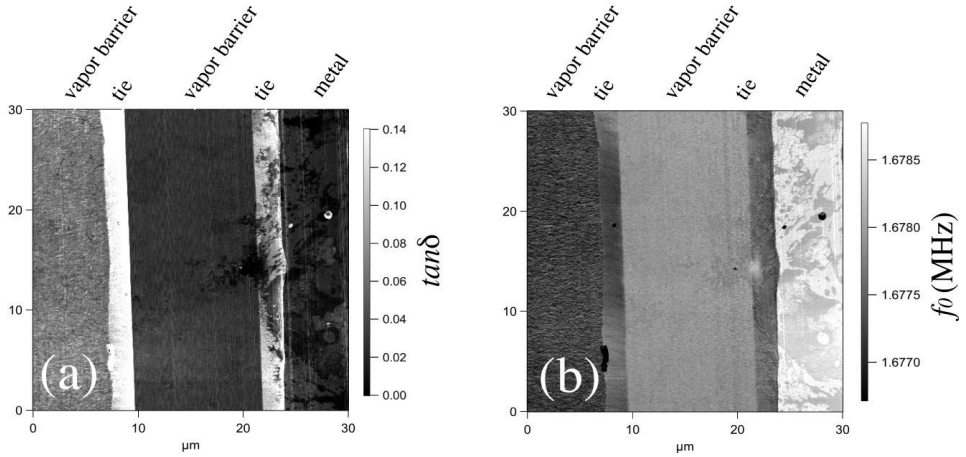

Figure 1 (a) loss tangent and (b) AM-FM image of a cryotomed packaging material.

References

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