Small amplitude force spectroscopy of confined liquids: Influence of surface chemistry, cantilever frequency, amplitude and approach speed.

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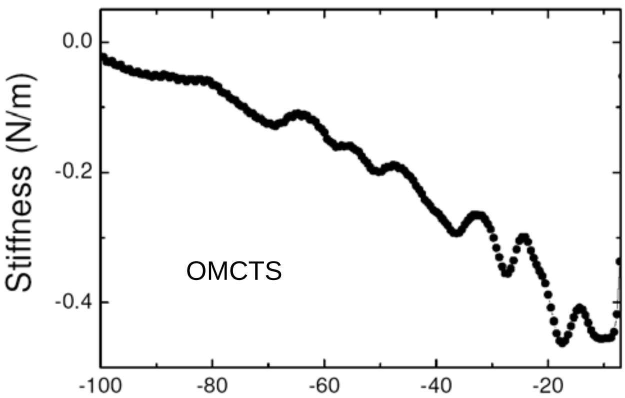
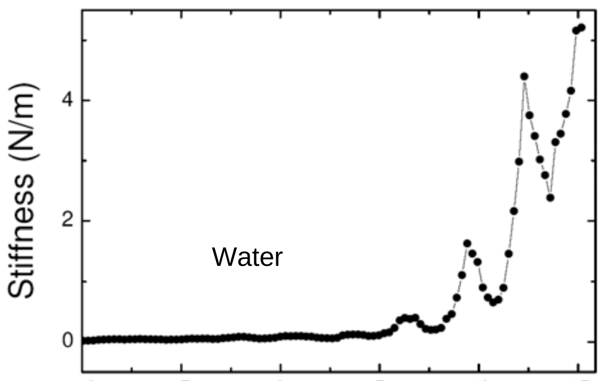
The nanomechanics of confined fluids has been of great interest for over 20 years, since force oscillations in confined liquids were first measured using the Surface Force Apparatus (SFA) [1]. Confined liquid systems continue to be of great interest because they have important implications for biology, nanotribology and nanofluidics. However, even after 20 years of intense research the reasons for the peculiar mechanical/dynamical behavior of confined liquids essentially remain a mystery. We have recently completed the construction of a new dynamic AFM that uses a fiber-interferometric deflection sensor to allow measurements at ultra-small amplitudes in liquids. Using this technique we have performed measurements of OMCTS (a commonly used model liquid) on a variety of surfaces, at different lever amplitudes & frequencies and different approach speeds. Our preliminary results suggest that in OMCTS the often seen attractive background forces in these measurements might be due to contamination of the confining surfaces and that changes in background forces do not correlate with changes in the observed stiffness oscillations. This suggests that in OMCTS background forces are mainly due to tip-substrate interactions (mediated by the intervening liquid), while the oscillations are mainly due to the confining geometry, rather than chemical interactions with the surface. We also found, surprisingly, that the approach speed of the cantilever to the surface changes the mechanical behavior dramatically, in accordance with recent results by Granick et al.[2] We will also compare the OMCTS results with results obtained in water and highlight commonalities and differences between these two systems [3].





[1] J. N. Israelachivili and R. M. Pashley, Nature **306**, 249 (1983).
[2] Y. Xhu and S. Granick, Langmuir **19**, 8148 (2003).
[3] S. Jeffery, P. M. Hoffmann, J. B. Pethica, C. Ramanujan, H. Ö. Özer, and A. Oral, Phys. Rev. B **70**, 054114 (2004).