Abstract Submitted
for the MAR12 Meeting of
The American Physical Society

Torsional tapping atomic force microscopy for molecular resolution imaging of soft matter JAMIE HOBBS, NIC MULLIN, University of Sheffield — Despite considerable advances in image resolution on challenging, soft systems, a method for obtaining molecular resolution on 'real' samples with significant surface roughness has remained elusive. Here we will show that a relatively new technique, torsional tapping AFM (TTAFM), is capable of imaging with resolution down to 3.7 Angrstrom on the surface of 'bulk' polymer films [1]. In TTAFM T-shaped cantilevers are driven into torsional oscillation. As the tip is offset from the rotation axis this provides a tapping motion. Due to the high frequency and Q of the oscillation and relatively small increase in spring constant, improved cantilever dynamics and force sensitivity are obtained. As the tip offset from the torsional axis is relatively small (typically 25 microns), the optical lever sensitivity is considerably improved compared to flexural oscillation. Combined these give a reduction in noise floor by a factor of 12 just by changing the cantilever geometry. The ensuing low noise allows the use of ultra-sharp 'whisker' tips with minimal blunting. As the cantilevers remain soft in the flexural axis, the force when imaging with error is also reduced, further protecting the tip. We will show that this combination allows routine imaging of the molecular structure of semicrystalline polymer films, including chain folds, loose loops and tie-chains in polyethylene, and the helical conformation of polypropylene within the crystal, using a standard, commercial AFM.

[1] N Mullin, JK Hobbs, PRL 107, 197801 (2011)

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Date submitted: 17 Nov 2011 Electronic form version 1.4