HIGH SPEED AFM – CONTACT & NON-CONTACT

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High-speed AFM imaging is important for many applications not least in biology where the ability to follow processes occurring in the millisecond regime at the molecular level is a major goal. High-speed imaging also allows greater areas of specimen to be examined in a given time, and it allows the patterning of surfaces over useful areas on a practical timescale for the creation of nanostructures. In recent years, Ando *et al*. [1] reported major achievements in high-speed tapping mode AFM. Here we will briefly present two alternative AFM techniques for achieving high-speed imaging.

The first of these methods for high-speed AFM imaging uses standard AFM cantilevers not operated in AC mode [2]. The specimen was either mounted on the resonant scanner or on a flexure stage capable of scanning at up to 40kHz. The AFM cantilever probe is brought into continuous contact with the specimen and the topographic structure derived for the deflection of the cantilever. A piezo stack provided the slow scan. Imaging at video rate is routinely achieved even on soft biological or organic molecules materials [3]. Damage to specimens resulting from this high-speed contact-mode imaging is surprisingly very considerably less than would be caused at normal speeds. Even samples having relatively large height differences such as hydrated human chromosomes have been imaged in liquid. Further recent developments of the instrument allow imaging >1000 frames per second [3].

The second new high-speed technique presented here is a non-contact force microscopy. It is recognized that non-contact imaging in liquid is of importance in biomolecular systems in order to cause the least distortion of the sample in an environment that is close to the natural state. Non-contact FM AFM techniques [4] have recently made a major step forward to attain these capabilities. The further challenge of high speed must be met in order to achieve the goal of following many biomolecular processes *in situ*. In the work presented here, we show a newly developed non-contact transverse dynamic force microscopy (TDFM) technique with the potential for high-speed imaging. TDFM has for many years been known to offer high-resolution imaging on delicate biological specimens in air or liquid in a non-contact mode, and these recent development, reported here, are a proof of concept of its capability as a high-speed imaging technique with the potential to image at video rate and beyond in a non-contact mode. TDFM approach curves show features associated with the ordering of water molecules above the sample. A demonstration of the 3D imaging of the water structure above a sample surface using the new version of TDFM will be presented. The visualization of local water structure in biomolecular systems is a dream for the understanding of structure formation and processes at the molecular level.

References:

[1] see, for example, T Ando, *et al. Jap. J. Appl. Phys. Part 1* **45 (2006)** 1897-190
[2] ADL Humphris, MJ Miles, & JK Hobbs, *Applied Physics Letters* **86** 2005) art no. 034106.
[3] LM Picco, *et al. Nanotechnology* **18** (2007) Art. No. 044030.
[4] T Fukuma *et al., Appl Phys Lett* **87** (2005) 034101.