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DriveAFM: Approaches towards combining high-resolution and large-range AFM imaging for materials and life science samples

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Abstract

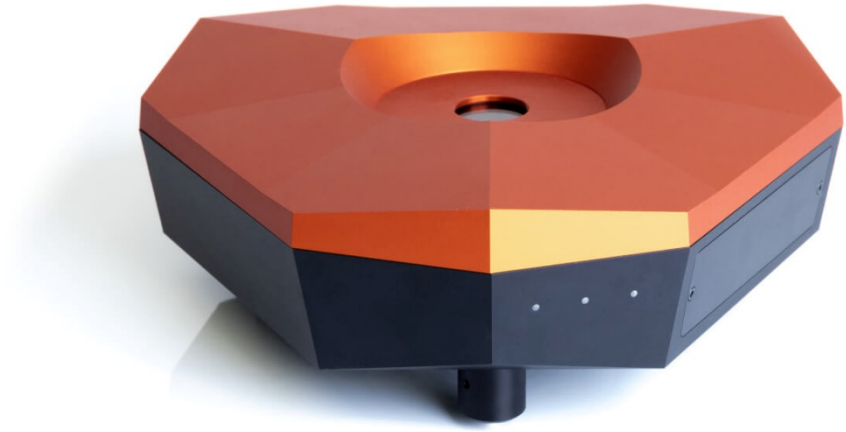

Figure 1: The Nanosurf DriveAFM scan head

Scanning probe microscopes are versatile tools because they can effectively resolve structures with length-scales from tens of micrometers down to the atomic-scale. Obtaining high quality images over scan sizes that may differ by more than five orders of magnitude presents a significant challenge in instrument design. In general, the stability of an instrument is improved by minimizing its size. However, for large sample systems, one must find novel approaches to maintain high stability which is required for high image quality down to the atomic level.

In this workshop, we present an overview of technological approaches used by our new instrument, the DriveAFM, which uses a novel optical design[1] that enables a fully motorized tip scanner with photothermal excitation, and is capable of both high-resolution and large-range imaging (see Figure 2). The primary innovations involve scan head and controller designs that reduce the impact of noise sources, both electronic and mechanical, and mitigate environmental effects which cause drift.

With these new developments, the DriveAFM provides new levels of user experience and performance for both materials and life sciences. CleanDrive photothermal excitation not only allows stable and reliable operation in liquid but also new applications in combination with inverted optical microscopy, such as PicoBalance mass monitoring of cells with high temporal resolution in the picogram range. In future, the full hardware motorization will enable automation of the system.

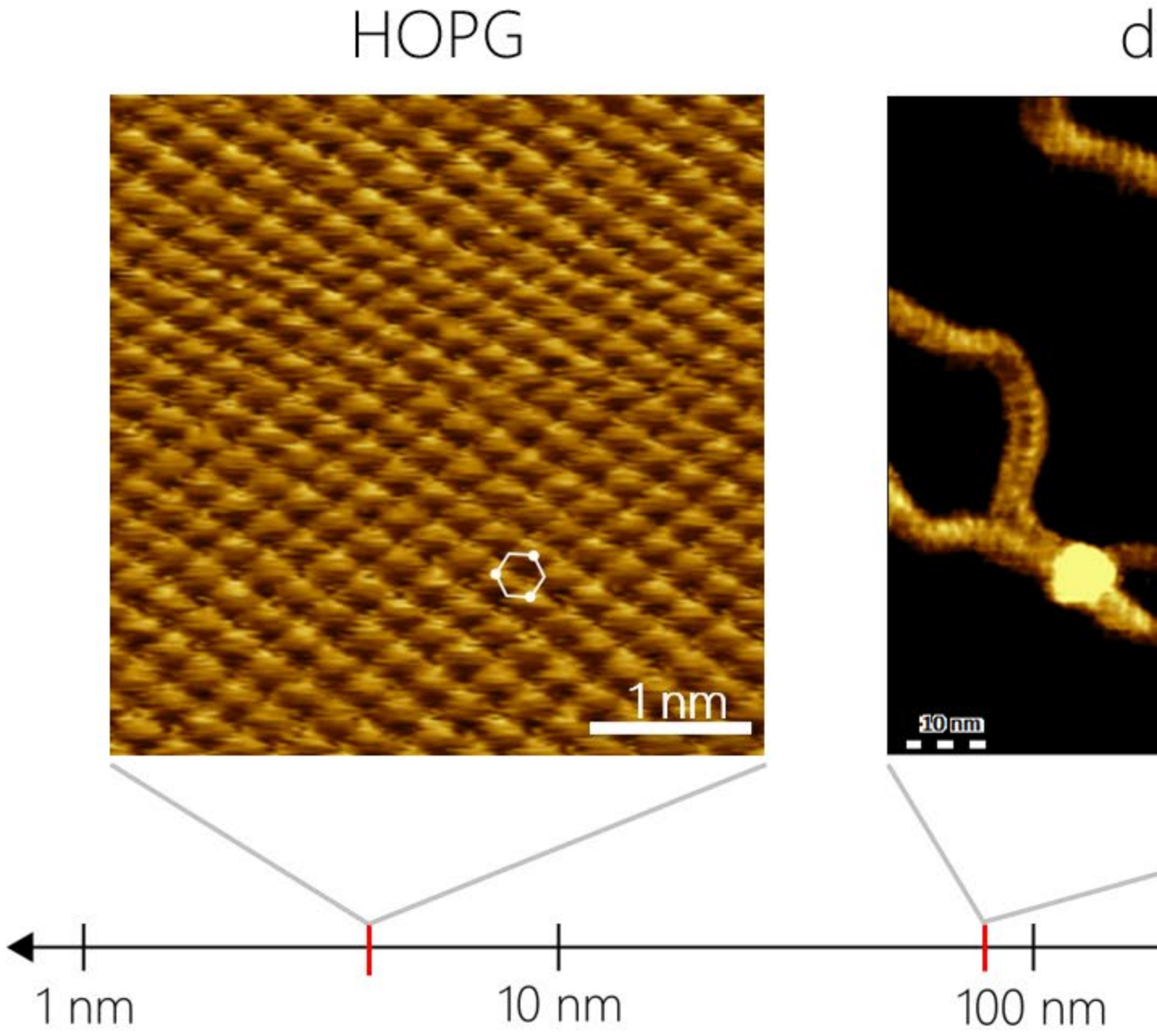

Figure 2: AFM images acquired with the DriveAFM at different length scales. Left: HOPG in contact mode in air (unfiltered), 4×4 nm^2. Middle: dsDNA in dynamic mode in buffer solution, 80x80 nm^2. Right: 3D topograph (with phase overlay) of a live fibroblast cell in culture medium at 37°C, 65×65 μm^2.

[1] Adams, J.D. U.S. Patent 10,564,181B2 (2020).