Viscoelastic Mapping of Living Cells Using FM-AFM

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Mechanical properties of living cells have attracted much attention in recent years, because they play an essential role in many physiological processes. We are developing a new technique of frequency modulated atomic force microscopy (FM-AFM), which can be used to measure the spatial distribution (spatial map) of the elastic modulus of living cells and their temporal evolution during different stages of cell growth and differentiation. To work in a liquid environment, we design a new AFM probe with a long glass needle glued on the AFM cantilever. The needle is long enough so that the AFM cantilever is kept in the air and only the needle tip touches the cell surface. With this new design, the AFM functions well in air and the needle tip provides an adequate spatial resolution to image the live cell surface in a liquid buffer. Interesting features of the cell surface, such as the actin-filament bundles of the cytoskeleton and lamellipodia protrusion, are observed with the FM-AFM. The AFM resonant frequency image and dissipation image provide quantitative information about the viscoelastic mapping of live cells, which are simultaneously measured together with the high-resolution cell morphology and cell height image.

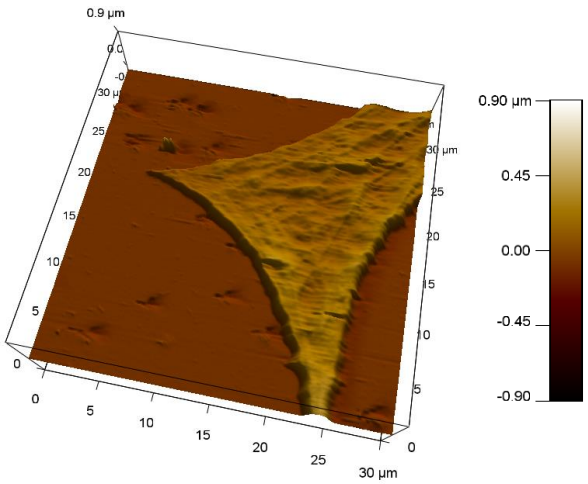

Figure 1. A three-dimensional (3D) height image of a portion of a Xenopus muscle cell in the PBS buffer.