# Embryonic Stem Cell Elastic Properties – F-d Spectroscopy

**Samples:**
Human embryonic stem cell
Muscle fiber

**Image Conditions:**
Contact Mode AFM
Force-distance measurement

**System Requirement:**
XE-100,
SLD Head
Spring constant calibration by thermal tune,
Liquid Probehand,
Liquid Cell

**The Benefits**
The XE-AFM series offers a highly sensitive force measurement mode for biological samples through the perpendicularity of the Z scanner to the sample surface. The force-distance mode enables the assessment of elastic differences between surface molecules.

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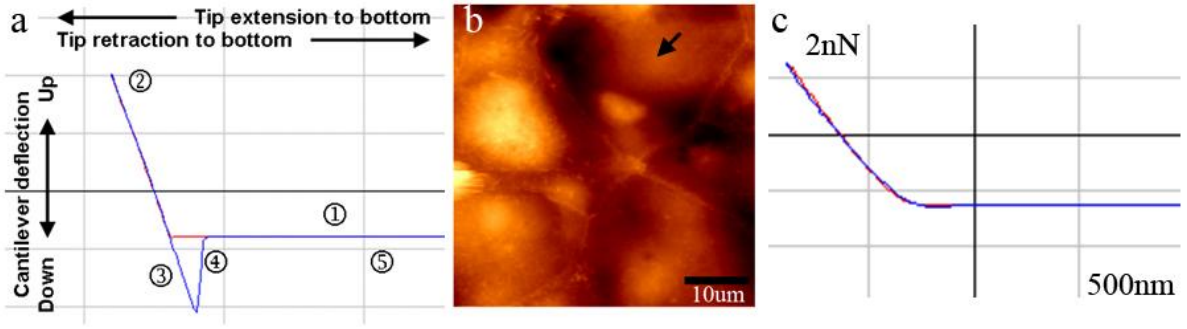


Fig 1a. AFM force-distance (F-d) curve on cover glass in air. The AFM was equipped with a super luminescence diode (SLD) and a cantilever with a spring constant of 0.06 K (N/m). The red line indicates the tip extension towards the sample (①②) and blue line indicates the tip retraction away from the sample (③④⑤). Downward cantilever deflection of the blue line indicates the adhesion force between the tip and sample (③④). b. Contact mode image of fixed human embryonic stem (hES) cells (45x45um). The arrow indicates the point where F-d curve (c) was obtained. c. The F-d curve of the hES cell. The attraction due to the meniscus force, shown in Fig 1a, is eliminated by performing the measurement in liquid. The gradual slope of the curve in the constant compliance region is related to the elastic properties of the cell.

The mechanical properties of biological systems play a major role in cellular processes. By recording and analyzing the F-d spectroscopy measurements by AFM, the elastic properties of biological systems can be determined quantitatively and reproducibly. Figs. 1a and c demonstrate the differences in force curves on stiff and soft samples. The deflection rises slower due to the deformation of the soft sample, which causes the gradual increase in the slope of the curve. Mechanical properties of many different cell types including glial cells, platelets, cardiocytes, macrophages, endothelial cells, epithelial cells, fibroblasts, bladder cells and more have been determined using F-d spectroscopy.

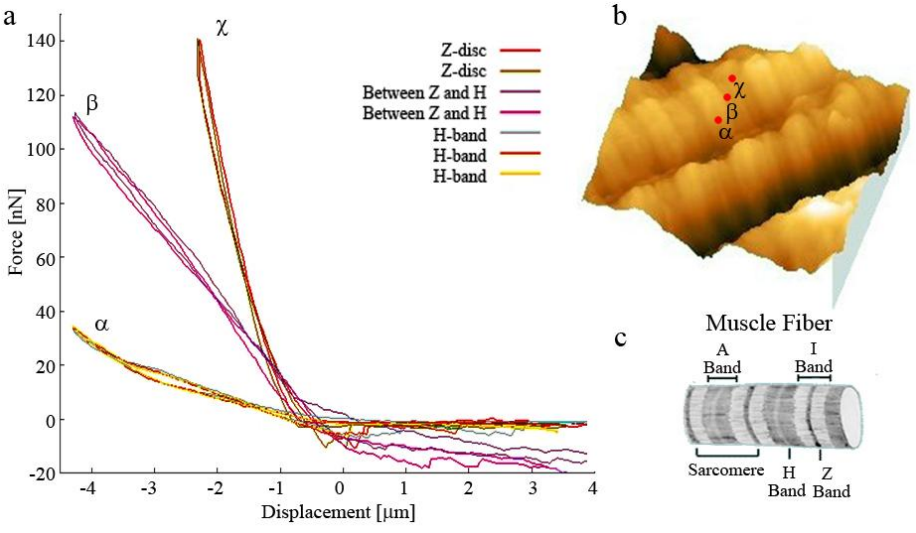


Fig 2a. F-d curve of the H-band (α), the structure between the Z and H bands (β) and the Z-band (χ). The differences in the slopes of curves indicate the different elastic properties of the structures. b. Red dots (α,β,χ) indicate the positions where F-d curves were taken. c. The structure of muscle fiber. (Image courtesy of Prof. N. Rozlosnik, DTU Nanotech, Denmark)

## Relevant Publications Using the XE-AFM


- Noemi Rozlosnik, 2006 Nanomechanics of Single Muscle Fibers by AFM, International Nano-Conference(ICN+T), Basel (CH)
- Mette Christensen, et al., 2009 Injection of marinade with actinidin increases tenderness of porcine M. biceps femoris and affects myofibrils and connective tissue, J. of the Science of Food and Agriculture, Vol. 89:1607-14
- Manfred Radmacher, 2002 Measuring the Elastic Properties of Living Cells by the Atomic Force Microscope. Methods in Cell Biology Vol. 68:67-90