AFM imaging of type I collagen fibrils

AN00955

Collagen is the most abundant protein in mammals and contributes to more than 25% of the whole-body protein content. It is the main structural protein of the extracellular matrix of connective tissues and provides e.g. tendons and bone with their tensile strength. Most of the collagen found in mammals is fibrillar type I collagen. Type I collagen fibrils show a typical periodic morphology, the so-called D-banding. D-bands result from staggered self-assembly of individual collagen molecules into larger fibrils with a periodicity of about 67 nm.

Figure 1. 3D representation of the AFM height image showing the typical periodic D-banding.

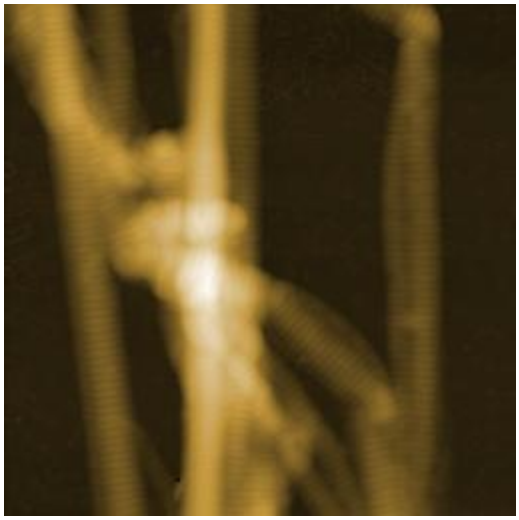

Figure 2. AFM height image of collagen fibrils recorded in static mode in air. All fibrils show the typical D banding.

Figure 3. AFM deflection image recorded along with the height image shown before. The D-banding is visible for all fibrils. As expected, fibrils oriented perpendicular to the fast scan axis show weaker contrast in the deflection image.

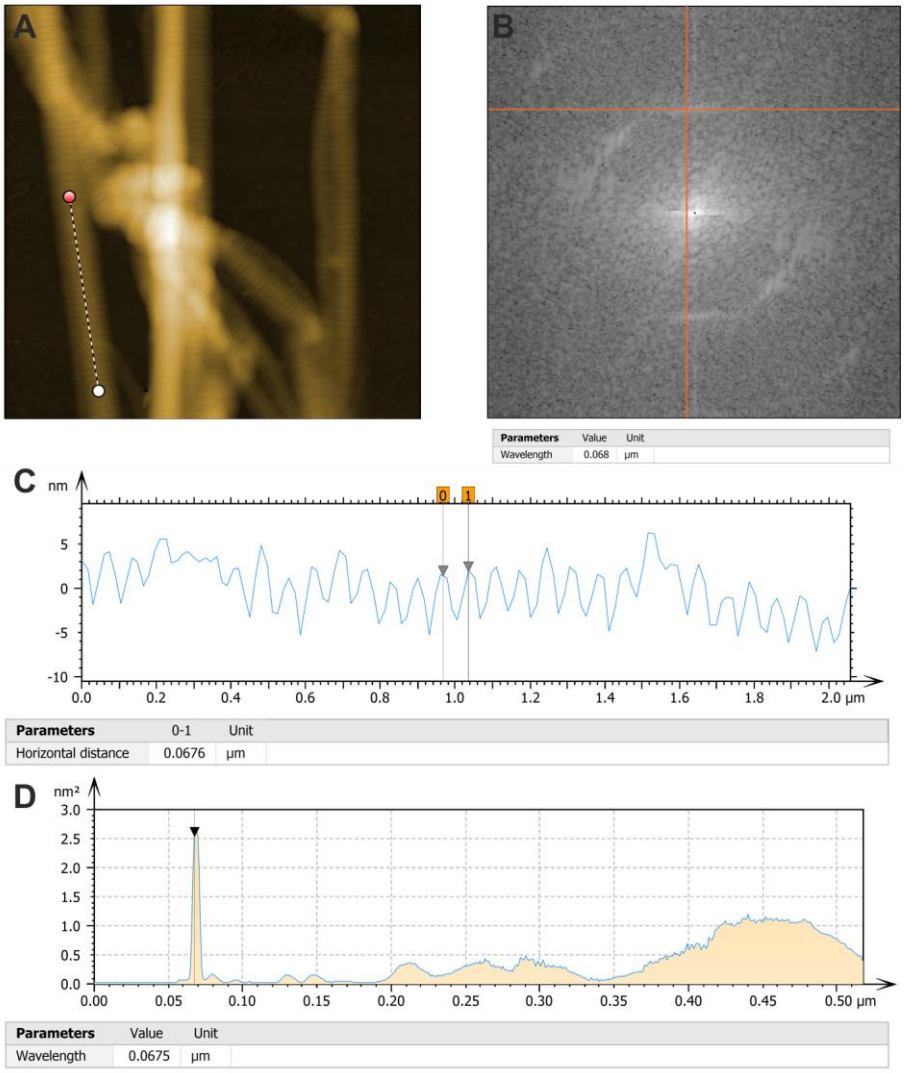

Figure 4. Analysis of collagen periodicity. (A) AFM height image of collagen fibrils. (B) 2D FFT spectrum of the AFM height image (A). The intensity maximum at the crosshair corresponds to the periodicity of collagen D-banding. (C) Height profile along the line indicated in the AFM height image (A). The two cursors measure the distance between two adjacent maxima to 67.6 nm. (D) Power spectral density spectrum of the height profile shown in (C). The spectrum shows a sharp peak at 67.5 nm that corresponds to the D-banding periodicity.

Experimental information:

Collagen fibrils were isolated from fascicles of 20 week old rat tails and spread on glass. AFM images were recorded in static mode on a Nanosurf ATS204 motorized stage using a Nanosurf C3000 controller and FlexAFM equipped with XYCONTR cantilevers.
AFM images were processed using Nanosurf Report software.
The image size is 4.35 µm; the full z-range corresponds to 300 nm (height images).

Preparation and imaging of collagen fibrils was performed by Massimo Bagnani, Prof. Snedeker research group, Uniklinik Balgrist, Institute for Biomechanics, ETH Zürich, Switzerland.