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Supporting information for article:

An *in situ* atomic force microscope for normal-incidence nanofocus X-ray experiments

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S1. Radiation damage

To validate the hypothesis present in the main text in section 4.2, namely that radiation damage to the polymer soft films is more pronounced in the region just beneath the tip, we have made a pattern by illuminating a virgin part of the sample. Figure S1 presents the results. In Figure S1a the sample is observed by the AFM prior to X-Ray illumination. Acquired this AFM image, the tip-sample relative position was made such that the tip was in the center of the image. The whole AFM was then moved with the beamline's hexapod, making a mesh of 10 X 10 illuminated points over 5 µm X 4 µm (centered in the original position). Each point of the sample was illuminated for 2 seconds. Figure 1b presents the AFM image after the X-Ray exposure. As it can be seen, looking from the top part to the bottom of the image, the sample damage increases dramatically, with the formation of large aggregates in the region extended from 5 µm to 10 µm below the tip position (pictorially represented with a black triangle). This is in agreement with the differences between Figure 5b and Figure 5c in the main text where the sample was submitted to a longer exposure (minutes).

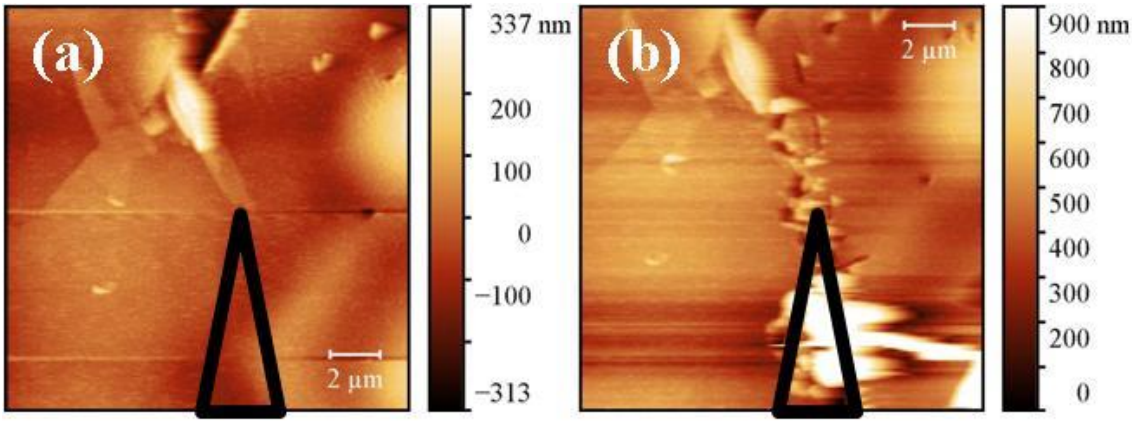

Figure S1 Radiation Damage on soft polymeric films: a) prior to illumination. b) after illumination. In black the position and shadow of the AFM tip during the exposure.

S2. AFM imaging speed *in-situ* at ID13

To test the high speed capabilities of this instrument we have performed images of the same sample *in-situ* with the AFM mounted on the sample stage of the beamline. Figure S2a, S2b and S2c present images of the soft polymeric films at three different scan rates. Figure S2a shows a slow scan (20 minutes) over a larger area. Figure S2b is a zoom of the top left zone of the previous image and the scan rate was faster (0.15 images/second).

The faster image is another zoom of this and was performed in 0.7 images/second. The main long range elongated structures of the sample are still visible, validating the fast imaging capabilities of the instrument.

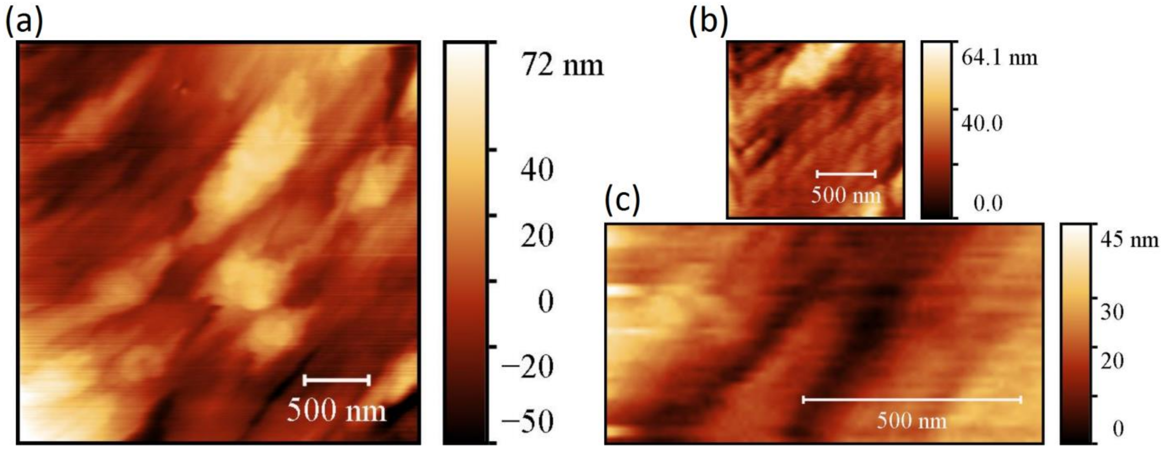

Figure S2 Figure S1 - Fast imaging on soft polymeric films. From a) to c) the scan rate increases (20 min per image, 6 sec per image and 1 sec per image).

S3. AFM imaging speed ex-situ

As supplementary material we provide a movie obtained ex-situ (at the Surface Science Lab. of the ESRF) of a silicon calibration grating sample, where the scan rate is 3.3 images/second. This constitutes the limiting scan rate of the instrument electronics.

S4. HS X-AFM adapted to imaging in liquid

In order to explore radiation effects of many biological systems the AFM has to be adapted to work in liquid environment. To achieve this, a supplementary cantilever holder was designed, which featured a glass window close to the cantilever. This avoids any water/air interfaces that misdirect the laser beam and prevent it from coupling back to the fiber. Figure S3 presents the two cantilever holders and a comparison of the interference signal in liquid and in air showing the two different wavelengths of light in the two media.

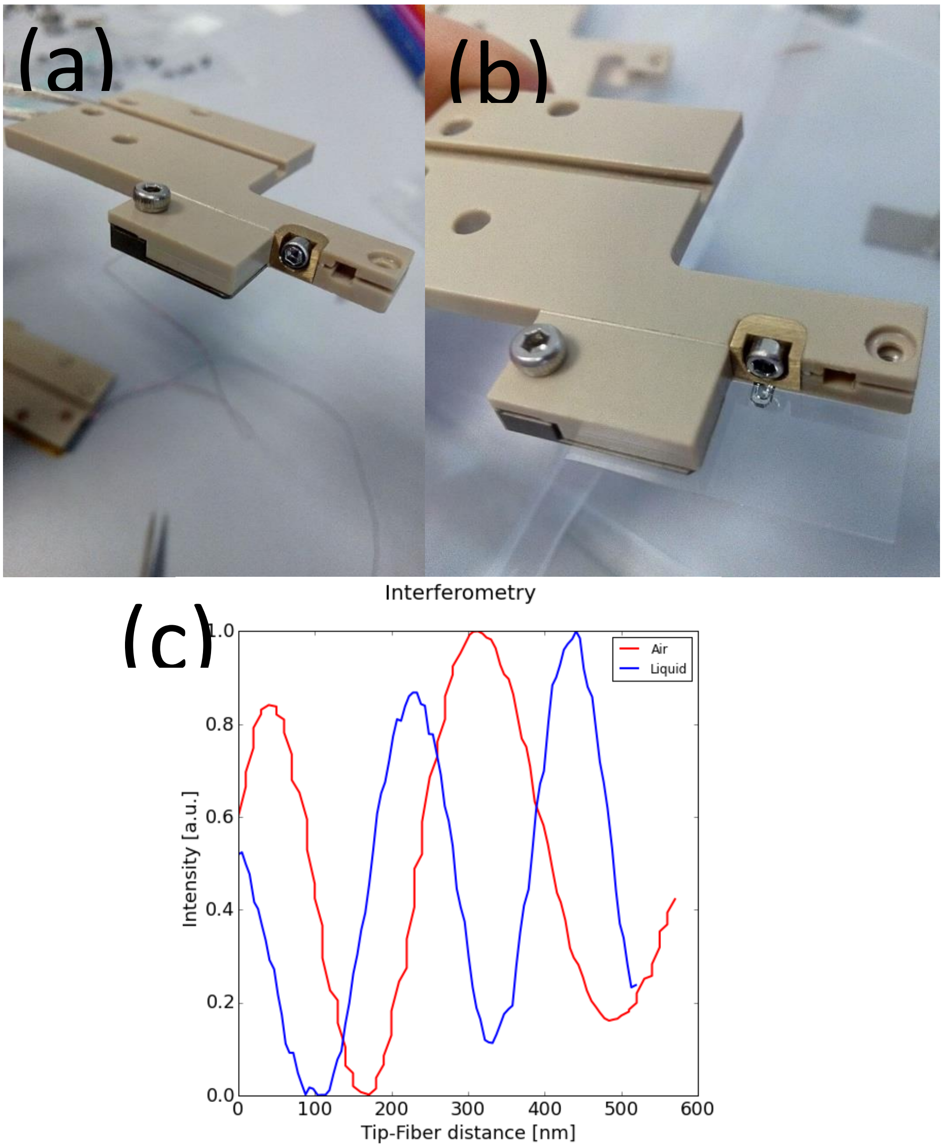

Figure S3 Figure S3 – Adaptation of the HS X-AFM to imaging in liquid environment: a) cantilever holder for imaging in air; (b) cantilever holder for imaging in liquid; (c) comparison between in-air and in-liquid interference signals measured with the AFM.