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Bruker Dimension Icon atomic force microscopy (AFM)

AFM is high-resolution scanning force microscopy, which uses a laser beam to detect the deflection of a cantilever with a tip scanning the sample, normally on a flat surface. For the AFM equipped with ScanAsyst-Air or ScanAsyst-Fluid+ probes, Peak-Force tapping mode is normally used for scanning, which can acquire high-quality imaging in air phase without damaging the sample significantly. With the correct setting, the mechanical properties can be acquired as the same time

There are quite some modes available to AFM measurements and a big number of probes for different functions. It's not possible to list everything feasible here. Rather, some typical measurements/calibrations are summaries here. Details need to be referred to the Bruker's help documents, PDF or video training materials

Every day using the AFM, put the date and user's name in the logbook. If anything happens, also log it. Every time after using it, turn off the software if the next user is more than 30 min later. If not sure, ask around. It won't hurt to turn off even if the next user is just 10 min away. At the end of the day, double check the off state of the software and the laser. Sometimes the laser stays on after the software is off. This indicates a faulty communication between the computer and the AFM (through a DSP cable). The related data collecting card was replaced by a good used unit in 2018-2019. It turns out to be better than the previous one. This faulty communication should happen less than once a month. Turn the system completely off on a weekly base (better 5-day base). This should maximise the longevity of the system

Regular Liquid AFM

Select ScanAsyst-Fluid+ probe and use in liquid probe holder. Avoid drying during the imaging process

1. Deposition of origami structures
    a. Get two pipettes. One for 2 μL sample and the other for 3 μL 25 mM nickel chloride. Suck the liquid aliquots in, respectively. Rest the pipettes on the desk. Due to the small amount, the liquid won't escape the pipette tips
    b. Cleave a mica surface and cover it with a petri dish
    c. The following processes have to be quick. Thus, practices with used pipette tips and tap water on dirty mica surface is very important. Add the sample and nickel chloride onto the mica, start a 30 s timer. Quickly cover the mica with a petri dish and stir to have the liquid cover most of the surface
    d. During the 30 s time, transfer the mica into the AFM hood, on the magnet. Once it is in place, the time is usually up or even late. Add 80 μL of the same buffer as in the sample to the mica
2. This deposition method is adapted from Hao Yan's work. It's subject to be changed as time goes on. For example, we can add Ni^{2+} into the buffer to avoid drastic change in concentration.
3. Use in liquid Peak-Force tapping mode to measure. Check the probe type in the set up before any scans. It's fine to adjust the laser and find the surface in other modes. Remember to change the mode back before the scan

a. The general procedure of in liquid is similar to in air. The difference is that liquid will case the light to go on a different track and the position where the laser hits can be hardly visible
b. Align the laser in air will be much easier. Make sure the laser is at the back of the tip of the probe using shadow method. For ScanAsyst-Fluid+ probe in liquid holder, the maximum sum value is 2 – 3 V in air. Sometimes 1.5 V is fine. The shadow might be hard to see, especially the laser dot. It can be big and vague. Careful tune the horizontal and vertical difference. The laser dot should be on upper left of the glass window if the horizontal is set as the major axis
c. Sometimes the horizontal and vertical difference can't be supressed no matter how the knobs are adjusted. This can be solved by placing the probe in a different place on the probe holder
d. For convenience of following measurements, the mica for shadow method should be the mica for deposition or very similar to that. Thus, the height will be the same. Record the Z value when reflection is clearly viewed in tip reflection view. Lift the head up 1 mm so that sample is clearly viewed in tip reflection view
e. Release the head from the locked position. If viewed from the top, the head is going to fall freely a little downwards and to the hood door direction. Push it in the front (from hood door to the back of AFM) so that it won't fall. Life it up (avoid touch the lenses and similar optical parts) and flip it cover
f. Get the mica with > 80 μL liquid ready with the sample deposited. Add 40 μL buffer (same as in the sample) to the lens on the liquid holder (installed on the head). Carefully flip the head back and let it slide back in place. Similar to uninstallation, push its front so that it won't fall too much. Lock it in place
g. The two droplets (80 and 40 μL) should have merged. Due to diffraction index difference between air and water, the track of light will change. Use the check box to compensate the difference of white light and adjust the laser to the right until the sum is big again. It can be really hard to see where the laser dot is. The operations are mostly by experience and understanding of the light
h. If the droplets are separated, try to get a good sum and lower the head. Otherwise add more liquid or redo the whole process
i. Adjust to get the regional maximum sum value (generally 4.2 V with liquid). Careful tune the horizontal and vertical difference (which is very different from dry condition)
j. Carefully lower the head until the tip is around 1.1 mm above the sample. Set the engaging parameters. Scan scale: 500 nm, x and y offset: 0 nm for the first scan, Z range ~12 μm. Try engaging
k. Z range and scan scale changing are all similar to dry AFM. The sample per line should be set to 256 regardless of scanning size. Force curve adjustments are also similar. Just that the peak force amplitude is normally bigger, can start with 50 nm
l. Scanning and saving are the same. Liquid separation after withdrawing happens a lot. Be prepared to add more liquid as scan goes or add a little more at the beginning

m. Once all the scan on a certain mica is finished, lift the head of AFM a little and remove the head. Clean all the liquid on the sample. If need to lower the head, try an air holder with bad probes just for laser reflection. Never leave wet equipment or sample inside the hood for too long, especially when not scanning