Bruker microCT

SkyScan 1272
How to set up a scan?

Method note

Overview workflow

1. Sample preparation and mounting on a sample holder
2. Sample positioning in the SkyScan 1272
    i. Fix the sample holder on the sample stage
    ii. Close the door
    iii. Switch on the x-ray source
    iv. Position region of interest sample in the camera field of view
    v. Set the pixel size
3. Optimize transmission through the sample
    i. Set the correct filter
    ii. Adjust voltage
4. Update the flat-field correction
    i. Remove the sample
    ii. Inactivate the flat-field correction
    iii. Adjust the exposure time and current in the ‘scanning modes’ menu
    iv. Update the flat-field correction in the ‘scanning modes’ menu
    v. Activate flat-field again
5. Reposition the sample (cfr step 2)
6. Evaluate image
7. Set acquisition settings in ‘acquisition’ menu
    i. Rotation step
    ii. Frame averaging
    iii. Random movement
    iv. 180/360° scan
    v. Partial width/offset scan
8. Start scan

Workflow in detail

1. Sample preparation and mounting on a sample holder

i. Different samples require different preparation/mounting techniques:
   - Scan dry or wet?
   - Scan at room temperature or keep the sample cool/frozen?
   - Scan in air, water, ethanol…?
   - Prevent movement of the sample!
   - Mount using polystyrene foam, double sided tape, wax, …?
   - …

ii. If possible resize your sample but make sure the size is still large enough to give representable data.

iii. The ideal shape of an object is a cylinder.

iv. Position the sample in the center of rotation to avoid misalignment artifacts and to allow for maximal zooming

2. Sample positioning in the SkyScan 1272

i. Fix the sample holder on the sample stage.

ii. Close the door.

iii. Switch on the x-ray source.

iv. If possible make the sample rotate completely inside the field of view:
   - The parts of the sample that rotate outside the field of view can't be reconstructed due to missing data.
   - One can also make advantage of the micro-positioning stage which is available in the SkyScan 1272 to center the sample from every angle.
   - When an object is larger than a field of view on a specific pixel size, on still has the option to run an offset scan (point 6).

v. Define a pixel size:
   - The pixel size is defined by a combination of the sample and camera position ('zoom') and the camera binning mode.
   - Note that the same pixel size can sometimes be set using different camera binning modes. In these cases, camera binning will reduce the scan time and increase the signal to noise ratio.

3. *Optimize transmission through the sample*

One key aspect of microCT imaging is partial absorption of X-rays in the sample. Too much transmission will reduce the contrast between different densities, while a low transmission will increase the noise level in the images. The transmission should be evaluated by inspecting the profile line in the acquisition software (activated by a single right click on the projection image). Adjust filter and voltage settings to get a minimum transmission between 10 and 50% (aim for 30% if possible). Note that these parameters should be adjusted for the highest dense part/angle in/of the sample.

i. Set the correct filter
   - A filter absorbs X-rays below a certain energy and thus increases the average energy of the X-ray beam. As a result, applying a (thicker) filter will increase the transmission through the sample and reduce beam hardening artifacts.
   - The SkyScan 1272 has 6 filter options (no filter, 0.25mm Al, 0.5mm Al, 1mm Al, 0.5mm Al + 0.038mm Cu and 0.25mm Cu filter).

ii. Adjust voltage
   - Changing the applied voltage will change the average energy of the X-ray spectrum. Increasing (decreasing) the applied voltage will increase (decrease) the average energy of the X-ray beam and thus increase (decrease) the transmission through the sample.
   - Guidelines for the combination of filter and voltage

Filter	Voltage
No	40-50 kV
0.025 mm Al	50-60 kV
0.5 mm Al	60-70 kV
1 mm Al	70-80 kV
0.5 mmAl + 0.038 mm Cu	80-90 kV
0.25 mm Cu	90-100 kV

Note that filter and voltage settings scan be selected automatically by the system (available as last option in the filter menu), however, one has to assure that all flat-field configurations are up to date to obtain the best result (cfr point 4).

4. Update the flat-field correction

The flat-field correction is a background correction that will make sure the background is always represented in the same grey level and will level out interpixel intensity variations that would otherwise result in ring artifacts. As such the flat-field correction is essential when a comparison is needed between multiple scans generated on different time points.
One should always update the flat-field correction upon changes in the following settings: filter, voltage, current, power of the source, camera binning mode and camera position (far-middle-near or offset mode).

i. Remove the sample from the field of view (either lower the sample below the camera field of view or take it out of the micro-CT).
ii. Inactivate the flat-field correction by double clicking in the top left corner of the field of view (indicated by ‘ff’ or ‘flat-field correction off’).
iii. Adjust the exposure time and current in the ‘scanning modes’ menu to get an average transmission in air between 40 and 70% without flat-field correction (aim for 60%). This can also be done automatically by selecting ‘adjust exposure automatically’ when updating the flat-field.
iv. In case the voltage/current are changed, update the numbers in the ‘scanning modes’ window accordingly.
v. Update the flat-field correction in the ‘scanning modes’ menu
vi. Activate flat-field again by double clicking in the top left corner of the field of view (indicated by ‘ff’ or ‘flat-field correction off’).

Note that this flat-field correction can be saved and re-used for similar samples. We recommend updating the flat-field correction at the start of the day, and when the above described settings are changed.

5. Reposition the sample

Cfr. step 1 and 2.

6. Evaluate image

Evaluate the transmission through the sample (cfr step 3). If the transmission is fine, proceed to step 7. If the transmission is too low or too high, repeat steps 3 and 4.

7. Set acquisition settings in 'acquisition' menu

i. Rotation step

- A smaller rotation step will increase the signal to noise ratio. Preferentially lower the rotation step (instead of increasing frame averaging) for low dense samples when the signal to noise ratio is too low.

- Guidelines for choosing the rotation step

Binning	Rotation step
1K mode	≤ 0.8°
2K mode	≤ 0.4°
4K mode	≤ 0.2°

ii. Frame averaging

- A higher number for frame averaging will increase the signal to noise ratio. Preferentially increase the frame averaging (instead of decreasing the rotation step) for high dense samples when the signal to noise ratio is too low.
- Guidelines for choosing the frame averaging

Binning	Frames
1K mode	1-4
2K mode	2-6
4K mode	4-8

iii. Random movement
- Can be activated to reduce ring artifacts.
- Don't use random movement with unstable samples or with very small pixel sizes.

iv. 180/360° scan
- 360° scans should be selected for samples consisting of a combination of high dense materials inside low dense materials to avoid depletion artifacts.

v. Partial width/offset scan
- By activating the partial width, the width of the projection imaged is cropped. Make sure the sample rotates within the new field of view (boundaries) at all angles. By activating the partial width, the rotation step can be slightly increased.
- The offset scan mode will double the width of the field of view by doing 2 or 3 scans subsequently side by side (change of the camera position). To preserve the signal to noise ratio, make sure you also decrease the rotation step with a factor 2 or 3.

8. Start scan