EUROPEAN SYNCHROTRON RADIATION FACILITY

INSTALLATION EUROPEENNE DE RAYONNEMENT SYNCHROTRON

Experiment Report Form

	Experiment title: 3D morphology of Ni wicks by X-ray tomography :insights into the thermal mass transport mechanism of loop heat pipes for space applications	**Experiment number**: MA-4845
Beamline:	**Date of experiment**: from: 28/04/2021 to: 01/05/2021	**Date of report**:
Shifts:	**Local contact(s)**: Alberto Bravin and Luca Fardin	*Received at ESRF:*

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Report:

The experiment aimed to investigate the internal structure (porosity, connectivity, and possible cracks or anisotropic distributions) of nickel wicks by X-ray tomography. The wicks are meant for aerospace applications, as a porous system allowing to dissipate heat through the evaporation of a refrigerant liquid. Therefore, the knowledge of the internal structure concerning the different synthesis methods and parameters is of paramount importance. The experiment was successfully fulfilled.

Two sets of wicks were investigated:

- 4 samples fabricated by 3D printing technique (Figure 1) having different pore size, 94µm (*JH2-w-2*) 50µm (*JH2-w-4*), 15µm (*JH2-w-6*), 35µm (*JS205*);
- 4 samples fabricated by classical sintering method using particles of different sizes, sintering temperature and time (*MRC1*, *MRC2*, *MRC3*, *MRC4*).

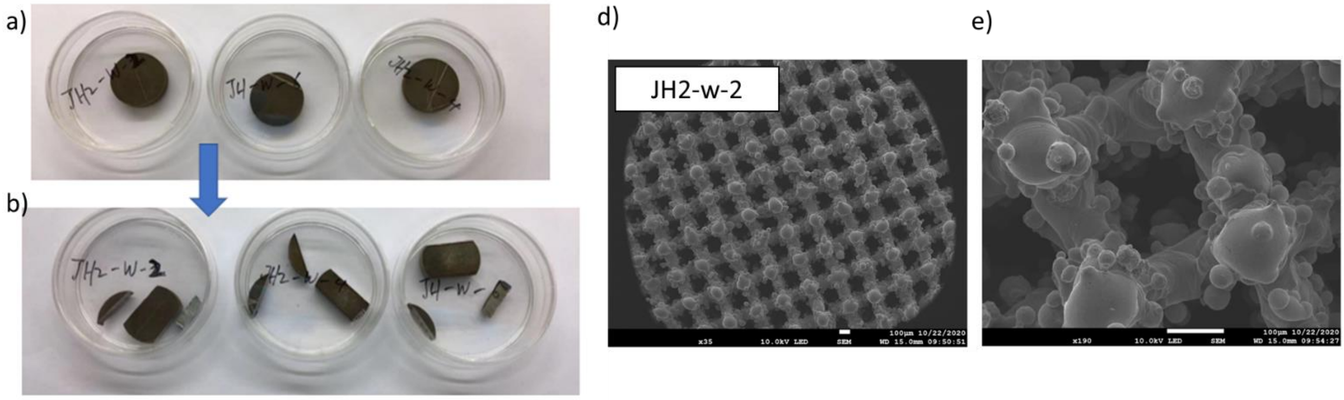

Figure 1: *picture of 3D-printing wicks with different pore sizes, before (a) and after (b) cutting; d-e) SEM images collected for the wick with the biggest pore size.*

Figure 2: *picture of some cut samples mounted on the sample holder before mounting on goniometer.*

The porous Ni-wicks samples were cylindrical-shaped, with a diameter of 22 mm and a thickness of 4 mm. To allow for sufficient transmission at an incident energy of 70keV, they were cut into three smaller pieces and mounted with the longer dimension perpendicular to the direction of the beam, as reported in Figure 2.

X-ray tomography was carried out on 13 contiguous volumes with a height of ~2.165mm along with the longitudinal (rotation) axis. The voxel size was 3.55µm (isotropic). Five thousand projections were acquired for each volume during rotation. The reconstruction process was performed remotely using the dedicated software (ID17rec) and resulted in 610 (or 521) slices.

Here, we report some images corresponding to samples *JH2-w-2* and *MCR2. The data were* imaged with the “3D slicer” software and analyzed qualitatively with ImageJ. Figure 3 shows three sections of sample *JH2-w-2*, which can be represented as a metallic grid. The three sections are done along with the grid directions. It is clear that large empty channels characterize this sample along with all three directions. Figure 4 shows three sections of sample MRC2. A macroscopic crack is visible, which is probably be due to the cutting of the sample.

A complete quantitative analysis of the sample porosity (pore size and distribution, tortuosity, connectivity,…) is ongoing using a dedicated software routine (https://github.com/ElettraSciComp/Pore3D).

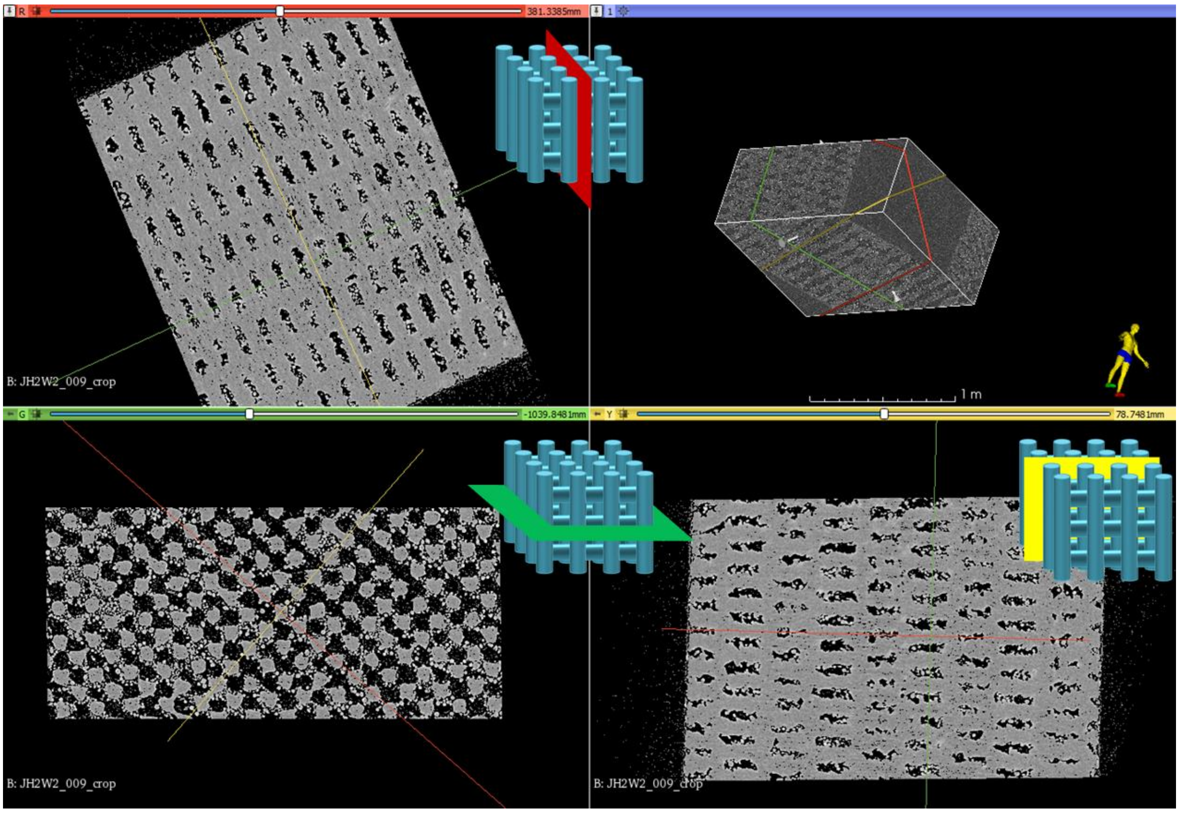

***Figure 3**: sections taken from volume 9 of sample JH2-w-2.*

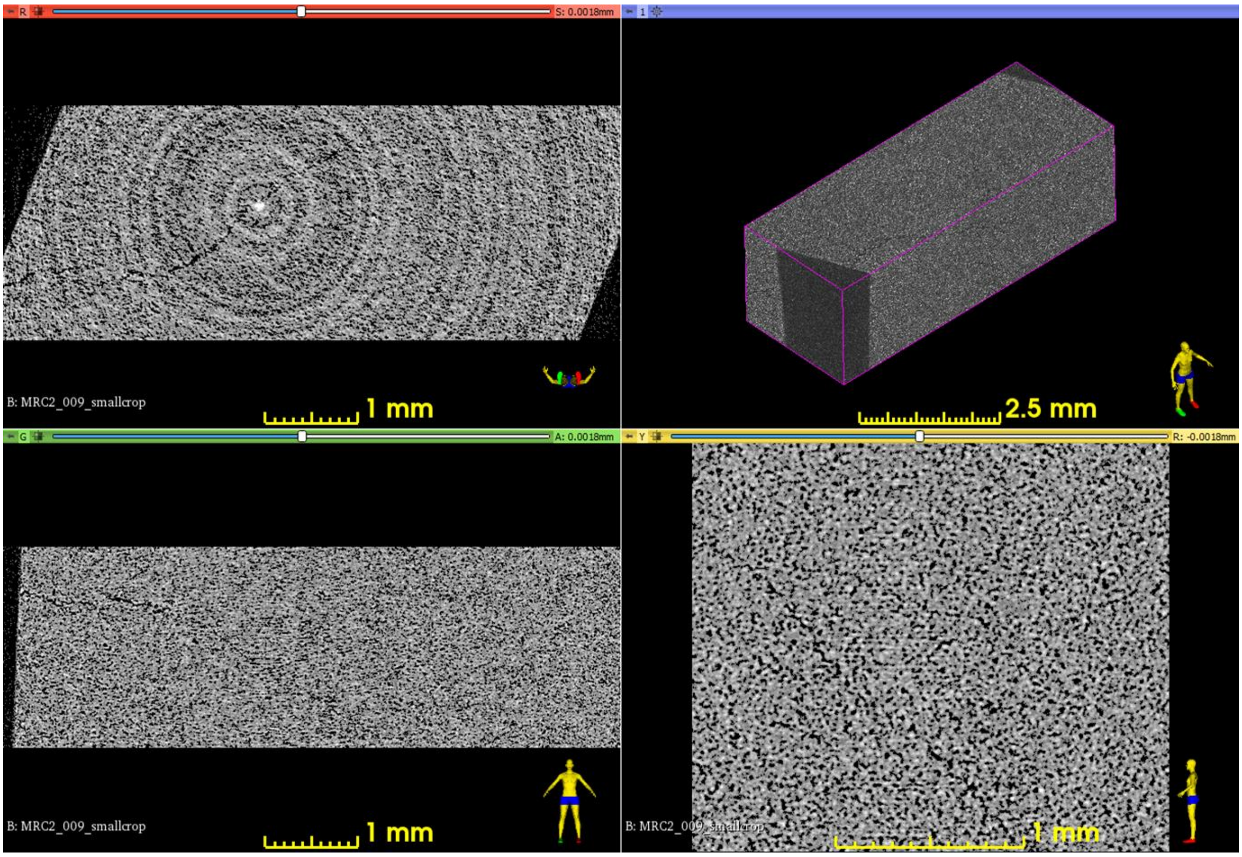

***Figure 4**: sections taken from volume 9 of sample MRC2*