ESRF	**Experiment title:** Development of spectral-ptychography technique for high-resolution quantitative and spectral imaging with applications in heterogeneous catalysis	**Experiment number**: MI-1346
Beamline: ID16B	**Date of experiment**: from: 26 Sep 2018 to: 28 Sep 2018	**Date of report**: 16/10/2019
Shifts: 6	**Local contact(s)**: Jussi-petteri Suuronen (email: jussi-petteri.suuronen@esrf.fr)	*Received at ESRF:*

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Report:

This beamtime concerned the official feasibility tests of Spectral-Ptychography at ID16B beamline. It was also the first demonstration of far-field X-ray ptychography at that beamline and the first time Spectral-Ptychography was performed at ESRF. The idea consisted in repeating the ptychographic imaging experiment at multiple energies around the absorption edge of the element of interest and also at the absorption edge.

Since the setup did not allow to perform rotations of the sample, we only scanned 2D samples. The chosen samples were thin 2D slices of Fluid Catalytic Cracking (FCC) catalysts deposited in Si_3N_4 membranes. Our goal was to localize through high resolution ptychographic imaging the distribution of Nickel (Ni) inside the sample morphological structure. The effects of Ni deposition is highly deleterious and it can shift the product selectivity of the FCC catalysts. We performed the experiments across the absorption edge of Ni, which is ~8.333 keV, since we wanted to detect the anomalous scattering of the Ni within the sample.

The first 3 shifts of the experiment were invested in the optimization of the beamline to perform ptychographic imaging scans. Since we needed to work at energies around 8.333 keV, the air can easily absorb the X-rays and a in-vacuum flight-tube between sample and detector was necessary. The flight-tube was included at the beamline since ID16B does not operate with a flight-tube in normal operation. For the detector, we used a PCO edge camera. We had to bin 4x the pixels of the camera, because they were too small and we want to collect a fair amount of photons.

The last 3 shifts were used to test several parameters to optimize the ptychographic scans. At the end of the days, we succeeded to make ptychography to work at ID16B beamline and the first result is shown in Figure 1. Due to time limitation and to slow movement of the motors at ID16B because the beamline is not optimized for ptychography, we could performed the scans at only 5 energies which we have to carefully selected trying to still detect anomalous effects. The energies chosen were: 8.32 keV, 8.333 keV , 8.346 keV , 8.349 keV, 8.376 keV. The scanned area of the samples was 30 microns x 30 microns with step size of 1 microns, since the beam size at the sample was of 2.5 microns. The reconstructed pixel size the phase-retrieved images was of 25nm.

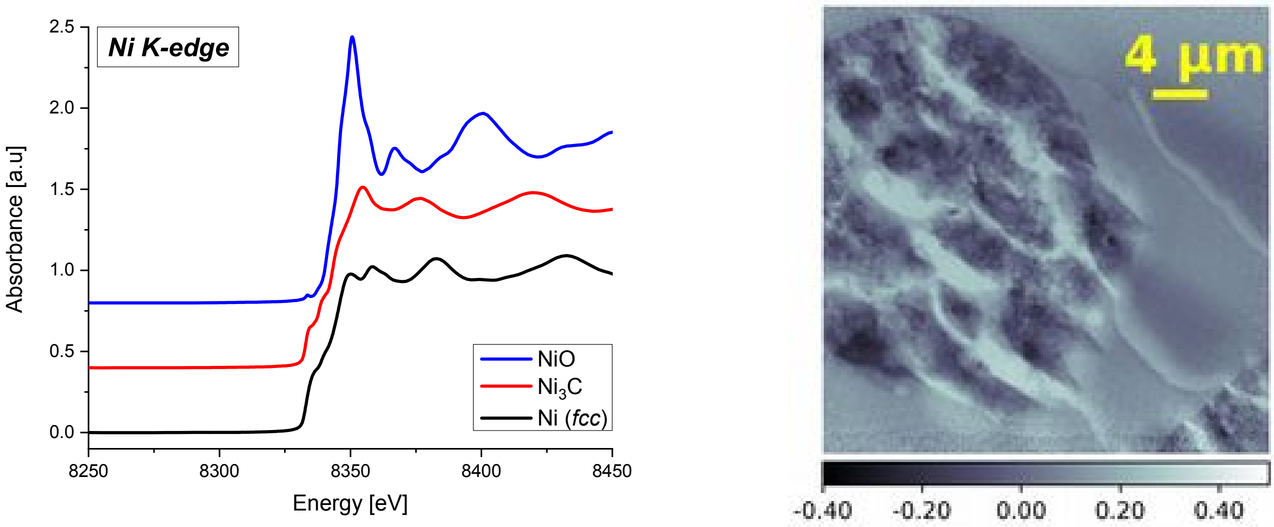

Figure 1. (left) XANES spectra of three species of Ni. (right) Phase-contrast ptychographic image of the sample obtained at 8.32 keV and first sucessful far-field X-ray ptychographic result at ID16B beamline.

We could conclude that the feasibility experiments of ptychographic imaging at ID16B were successful, despite problems with the sample preparation. Those problems cause sample movements on the top of the Si_3N4 membranes during the scan. Although we were successful with the ptychography scan, the resulting imaging contain movement artefacts. And we could not prepare new samples in only two days. However, anomalous effects were indeed detected and those experiments constitute a big step forward in the development of Spectral-Ptychography at ID16B beamline and at ESRF. We plan to repeat the experiments with better sample preparation to really officially conclude the experiments and prepare a publication. Additionally, we plan to explore new opportunities to perform Spectral-Ptychography with the new ESRF-EBS source. We also wish to develop the 3D spectral ptychographic imaging.