X-ray Spectral-ptychographic imaging for the characterization of technical catalyst bodies

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X-ray Spectral-ptychography is a combination of ptychography and spectroscopy and this approach is emerging in synchrotron facilities. One important domain of application is the characterization of technical catalysts. One example is the Fluid Catalytic Cracking (FCC) bodies, which are very important industrial catalysts in oil refinery. We have already characterized the morphology of FCC catalytic particles by standard ptychographic-tomography (Fig. 1) [1,2]. However, metals such as Nickel (Ni) poison the active sites of the FCC catalyst bodies during operation in the FCC reactor. This leads to problem of decreased activity and selectivity as well as increasing coking problems. Therefore, the characterization of the distribution of metals and their speciation within the particle structure can help to optimize the catalyst structure in order to reduce this poisoning and extend the time-of-life of those catalysts. The spatial resolution in classical spectral imaging is limited by the beam sizes available, which is not high enough for this characterization. Spectral-ptychography, on the other hand, enables morphological and spectral information of the samples with high-resolution, independent of the beam size used for the imaging. Here we present a demonstration of spectral-ptychography carried out at ID16B beamline of ESRF for the characterization of FCC catalyst bodies. We performed the experiment across the Ni K-edge, which is 8.333 keV, to identify the locations and speciation of Ni within the sample. In the context of the ESRF-EBS, this innovative technique opens new opportunities for the characterization of heterogeneous materials, not only catalysts, in which the correlation between morphology and spectral information is necessary.

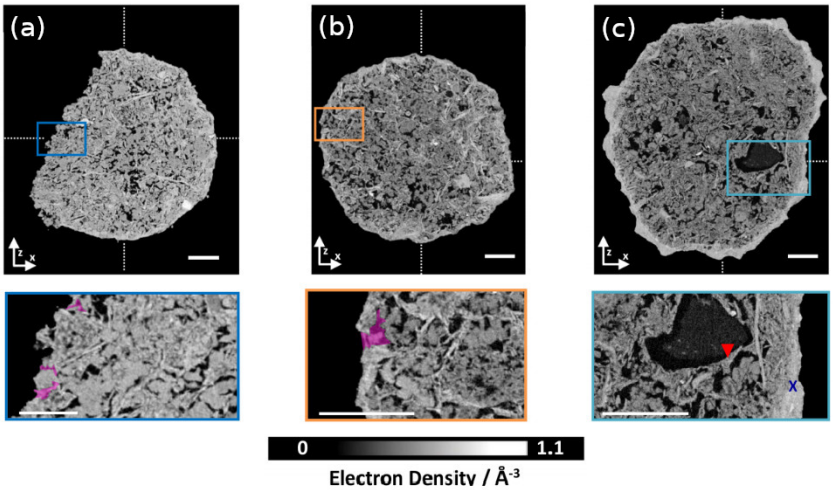

Figure 1: FCC catalyst bodies at three stage of life: (a) pristine; (b) middle life; (c) deactivated and contaminated with coke.

References

[1] – J. Ihli et al., Nat. Communications 8, 809 (2017)
[2] – J. da Silva et al., ChemCatChem 7, 413 (2015)