Imaging Hierarchically NanoPorous Catalysts with Coherent x-ray Diffractive Imaging: New Opportunities at Sirius the Brazilian Ultra-Low Emittance Synchrotron Facility

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Abstract

Novel 4th generation synchrotron facilities and X-ray free-electron lasers are leading to the development of new X-ray methods of microscopy. Among these techniques, coherent diffractive imaging (CDI) is one of the most promising, enabling nanometre-scale imaging of non-crystallographic samples. Indeed, new visualisation methods can be used to resolve structures at resolutions that were previously unachievable. Here, I will present the application of ptychographic X-ray computed tomography for the visualisation of soft matter with a resolution of ~26 nm over large fields of view. Thanks to the high-penetration depth of the X-ray beam, we visualised the 3D complex porous structure of polymer hollow fibers in a non-destructive manner and obtain quantitative information about pore size distribution and pore network interconnectivity across the whole membrane wall. The non-destructive nature of this method, coupled with its ability to image samples without requiring modification or a high vacuum environment, makes it valuable in the fields of porous- and nano-material sciences enabling imaging under different environmental conditions [1]. Moreover, the very recent implementation of plane-wave CDI enabled to image a 10 micron-size MCM22 zeolite crystal, three-dimensionally. The total experiment time was less than 2 hours with a resolution close to 50 nm. With further improvements, the temporal resolution of plane-wave CDI will pave the way to novel *in situ* time-resolved and *in operando* nanotomography studies exploring real-time phenomenon, spanning chemistry, biology, catalysis and materials research fields. These methods are implemented at the Cateretê beamline [2] at the SIRIUS 4th generation synchrotron source based multibend achromat lattice [3].

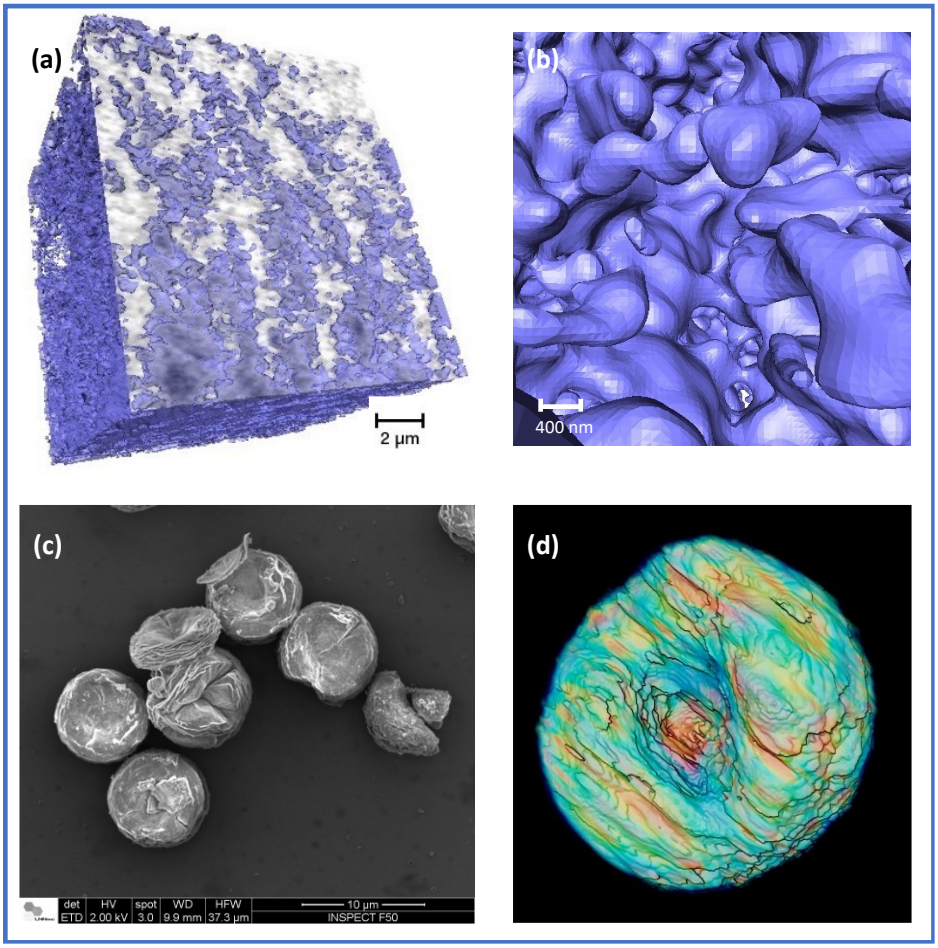

Figure: (a) Ptychographic X-ray computed nanotomography performed at the Cateretê beamline @ Sirius, of a polystyrene-block-poly(acrylic acid) (PSPAA) specimen. (b) Three-dimensional rendering of the commercial PSPAA and zoom into the polymeric network. Blue colour corresponds to the matrix and white to the pores. (c) Scanning electron microscopy of MCM22 zeolite crystals. (d) Three-dimensional reconstruction of the MCM22 crystal measured using plane-wave coherent diffractive technique at the Cateretê beamline @ Sirius.

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