Quantitative and chemical nanoimaging of heterogeneous materials by 3D X-ray ptychography

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The properties of functional composite materials are heavily affected by the arrangement of the different material phases within their 3D structure. The ability of visualizing their structures with high sensitivity and nanometric spatial resolution can improve the engineering of these composites. Ptychography is coherent X-ray imaging technique that has revolutionized this type of characterization[1]. We will show that ptychographic X-ray computed tomography (PXCT) is the key imaging technique to reconstruct quantitative 3D images of heterogeneous materials in such a critical length scale and with relatively large field-of-view[2-6]. PXCT provides 3D images from which we can extract the localization of the different material phases, the intermaterial pore space[1,2], and the composition of each constituent material of the composite without the need of additional spectroscopic measurements[4,5]. We will present a few examples of applications such as the analysis of the structure of technical catalysts bodies for the oil industry[2,3], the quantitative characterization of the hydration products of cement pastes[4,5], and the characterization of metallic alloys for aerospace industry[6]. We will also be discussing rapidly the future possibilities of using coherent X-ray beams in the new generation of synchrotron sources and development prospects at ESRF's FAME and D2AM French CRG beamlines.

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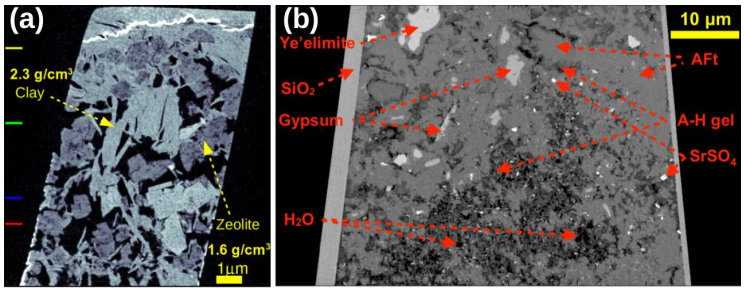

Figure 1: Examples of characterization of heterogeneous materials by PXCT: (a) Catalyst bodies for oil industry[2,3] and (b) hydrated eco-cement paste[4,5].