CHARACTERIZATION OF DEFORMATION MECHANISMS IN POLYMER AND COMPOSITE MATERIALS VIA THREE DIMENSIONAL X-RAY IMAGING AND DIFFRACTION

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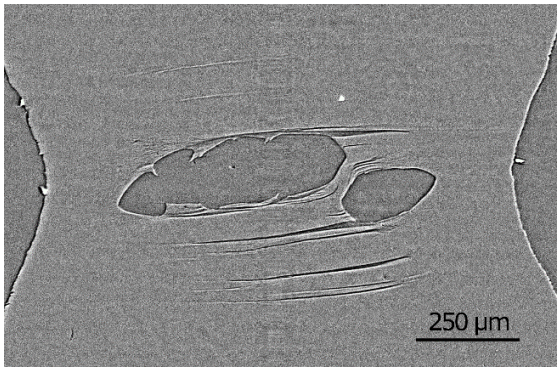

Internal cracks seen by absorption tomography

Key experimental points:

- Phase Contrast Tomography
- Angle and energy-dispersive diffraction
- Diffraction-tomography
- In situ mechanical testing at the synchrotron
- Elucidate links between microstructure and material strength.

Abstract:

PEKK (Poly-Ether-Ketone-Ketone) is a high-performance polymer material developed by Arkema. This material is destined to be used as the polymer matrix in future composite materials in highly demanding areas of application such as aerospace and offshore energy, industries requiring replacements for metallic materials and structures. Such composite materials promise weight savings while maintaining excellent mechanical and industrial properties (lightweight, strength at elevated temperature, formability and recyclability). The material is used in a semi-crystalline condition and the crystalline part is crucial for keeping mechanical strength with increasing temperature.

Polymer materials experience multiple damage processes. In situ testing combined with tomography allows the study of porosity and cavitation once pores reach a sufficient size, but this corresponds to a very advanced state of damage. The aim of this subject is to explore also, in the same experiment, prior microstructural changes revealed by diffraction with a spatially-resolved approach. Several key parameters such as degree of crystallinity, polymer chain orientation, crystallite fragmentation... are determinant for mechanical properties and lifetime but are not visible by absorption tomography. The understanding of the evolution of these parameters during deformation is fundamental for better lifetime predictions and the design of polymers and polymer-based composites.