22nd International Conference on
Diffusion in Solids and Liquids
22 TO 26 JUNE 2026 | RHODES, GREECE

ABSTRACT:

Surface X-ray Scattering for Functional Materials – Beyond the Single-Crystal Paradigm

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The SixS beamline (Surfaces Interfaces X-ray Scattering) at Synchrotron SOLEIL is dedicated to studying surfaces, interfaces, and nanostructures using surface-sensitive X-ray scattering methods, such as Grazing Incidence X-ray Diffraction (GIXD), Grazing Incidence Small-Angle X-ray Scattering (GISAXS), Surface X-ray Diffraction (SXRD), and X-ray Reflectivity (XRR), covering photon energies from 5 to 20 keV. More recently, Bragg Coherent Diffraction Imaging (BCDI) has been implemented at the beamline, enabling single-object imaging and thereby overcoming the ensemble averaging inherent to diffraction-based methods. Together, these techniques provide structural insight spanning from the atomic scale through the nanoscale to the micrometer range. They can be performed in situ and in real time under a wide variety of environmental conditions, thanks to two experimental endstations: one dedicated to ultra-high vacuum experiments, and a multi-environment station equipped with a heavy-load diffractimeter which can accommodate divers setups.

While these techniques are often perceived as suited mostly to nearly perfect single crystals, epitaxial films, and model particles, they can be applied to a much broader class of materials. Several scientific examples will showcase this versatility across distinct fields, including phase quantification in ultrathin polycrystalline ferroelectric oxide films, detection of subtle structural deformations in self-organized soft matter layers, and depth-dependent analysis of environmental degradation in aged polymer materials, among others.