

Synchrotron radiation and material science

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Advanced materials—including nanomaterials, fibers, and biomaterials—derive their distinctive properties from the structural organization of their constituent building blocks, whose atomic- and nanometer-scale order or disorder plays a fundamental role in determining material behavior. A detailed understanding of these structural characteristics is therefore crucial for tailoring material properties, optimizing performance, and fostering technological innovation in fields ranging from energy and electronics to healthcare and the circular economy. Among the most powerful non-destructive approaches for investigating structure, X-ray Diffraction (XRD) and Small- and Wide-Angle X-ray Scattering (SAXS/WAXS) provide complementary insights across different length scales [1,2]. This lesson will explore the potential of these techniques through selected practical examples, including colloidal nanocrystals [3,4], nanocrystal-based superlattices [5–7], and engineered fiber-based materials [8,9]. The capabilities of today's laboratory-scale instrumentation [10] for preliminary sample screening and for selecting suitable samples and experimental conditions prior to measurements at large-scale infrastructures will also be discussed.

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