Focused and coherent X-ray beams for advanced microscopies

Poster/Oral Presentation
Date of presentation
Time of presentation

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Sensitivity of X-rays to electrons provides access to information about materials at the atomic level: atomic structure and elemental composition, lateral order (crystal structure and meso-structure), lateral configurations (2D and 3D morphology and strain), spin order (magnetic order and domains) and electronic structure can be revealed and studied. When combined with the use of focused beams [1], this sensitivity generates a multi-modal scanning microscopy of intrinsic correlative nature. When coherence of X-rays is included, increased lateral resolution -and one extra dimension -are added to the benefits [2].

This lecture will focus on the use of hard X-ray nanobeam *diffraction* microscopy as advanced tool for studying functional materials, with the use of a few examples of their combination with coherence and spectroscopy [2,3,4].

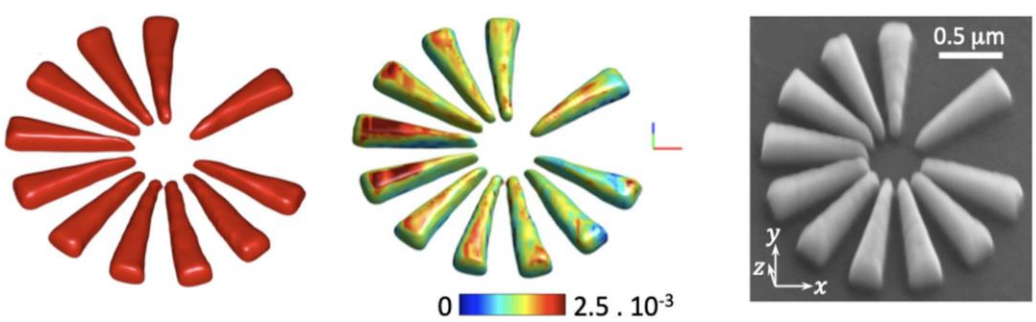

Figure 1. Example of 3D reconstruction of a Si crystal structure from inversion of coherent X-ray data, (from Ref. 2) illustrating (*left)* the sample morphology and (center) strain field along the vertical direction. Comparison with a SEM image is shown on the right.

References

1. J. Stangl *et al.,* "Nanobeam X-Ray Scattering: Probing Matter at the Nanoscale" Wiley-VCH Verlag GmbH & Co ISBN: 978-3-527-41077-4 (2013)
2. P. Li *et al., Light Sci Appl* **11**, 73 (2022); https://www.maxiv.lu.se/news/4th-generation-x-ray-brilliance-and-nanoscale-microscopy-reveal-clearest-crystalline-form/
3. Evans *et al*., Sci. Adv. 6**,** eaba935 (2020)
4. S. Remiers *et al*., *Nat Commun* **13**, 724 (2022)