MS39 Crystallography at the nanoscale

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Investigation of Materials at the Nanoscale Using Hard X-ray Nanoprobes
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Abstract
Owing to the spatial resolution and sensitivity (i.e., signal to background ratio), synchrotron nanobeams are promising tools with a strong impact in nanoscience [1]. Although the optical quality of the X-ray focusing optics has limited the progress of hard X-ray nanoprobes, recent progresses in fabrication approaches have pushed the spatial resolution towards the diffraction limit. Consequently, the exploitation of X-ray nanobeams has begun to extend towards the atomic domain, with concomitant and continuous developments of multiple
analytical techniques. The study of nanoscale objects, small embedded nanodomains with weak signals and/or heterogeneous nanostructures has demanded the use of intense X-ray
pencil beams. In addition, the extreme brilliance with reduced emittance of new synchrotron sources and novel X-ray detection schemes have boosted nowadays intense X-ray
nanobeams using several focusing devices. Due to the multiple interactions of X-rays with matter these X-ray nanoprobes present manifold capacities, such as ultra-sensitive
elemental/chemical detection by X-ray fluorescence/X-ray absorption, or identification of minority polytypes, and/or strain fields by X-ray diffraction with nanometre resolution. In the
present talk I describe how hard X-ray nanobeams are produced and exploited currently for space-resolved determination of structural and electronic properties, as well as for chemical speciation of nanosized materials even under in situ conditions. Selected recent examples will range from phase separation in single nanowires to visualization of degradation mechanisms under device operation, inversion domains and buried interfacial defects, to structural distortions and quantum confinement effects at low temperatures.

References
[1] L. Mino, E. Borfecchia, J. Segura-Ruiz, C. Giannini, G. Martinez-Criado, and C. Lamberti, Materials characterization by synchrotron X-ray microprobes and nanoprobes, Reviews of Modern Physics, 90 (2018) 025007.