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Highlights of the X-ray Nanoprobe CARNAÚBA Beamline at the SIRIUS/LNLS

Wednesday 28 August 2024 12:00 (15 minutes)

This contribution presents the main developments and science outcomes of the CARNAÚBA X-ray nanoprobe beamline, recently installed at the new SIRIUS 4th-generation synchrotron source at the Brazilian Synchrotron Light Laboratory (LNLS). The beamline has operated since November 2020 for technical and scientific commissioning and since 2022 for standard user proposals. Its design uses high-resolution multi-analytical and coherent X-ray imaging techniques over the energy domain of 2.05 to 15 keV. An all-achromatic mirror-based optics provides the nano-focused beam. The normal beamline operation employs a monochromatic beam in a high-energy resolution mode using a 4-bounce Si(111) crystal monochromator [1].
The first nanoprobe station, TARUMÃ, provides diverse sample environments for in situ, operando, cryogenic, and in vivo experiments. The sample environment is raster-scanned through the nanoprobe to generate fast two-dimensional maps of simultaneous contrasts, which can then be combined with a rotation for computed tomography. The performance has attained the main specifications, with the predicted flux of 1010 photons/s/100-mA/0.01%BW and a focus size of 180x180 nm2, measured at 10 keV in fluorescence and transmission modes. X-ray ptychography with a monochromatic beam provides a resolution down to 12 nm.
We will briefly discuss the main technical characteristics of the X-ray nanoprobe instrument, emphasizing the first deployed experimental station, TARUMÃ, and showcases results in a broad range of areas that benefit from diverse sample environments. Research domains like photovoltaics, photonics, electrocatalysis, geoscience, and environment are investigated from the viewpoint of chemistry, atomic structure, morphology, and redox dynamics phenomena covered by the beamline techniques [2-6].
[1] H.C.N. Tolentino, et al., The CARNAÚBA X-ray nanospectroscopy beamline at the Sirius-LNLS synchrotron light source: developments, commissioning, and first science at the TARUMÃ station, J. Electron Spectros. Relat. Phenom. 266 (2023) 147340.
[2] I.T. Neckel, et al, Development of a sticker sealed microfluidic device for in situ analytical measurements using synchrotron radiation, Sci Rep. 11 (2021) 23671.
[3] J.A. Barbosa, et al, Biocompatible Wearable Electrodes on Leaves toward the On-Site Monitoring of Water Loss from Plants, ACS Appl Mater Interfaces. 14 (2022) 22989.
[4] G.C. Sedenho, et al, Investigation of Water Splitting Reaction by a Multicopper Oxidase through X-ray Absorption Nanospectroelectrochemistry, Adv Energy Mater. 12 (2022) 2202485.
[5] R. de Oliveira, et al, High throughput investigation of an emergent and naturally abundant 2D material: Clinochlore, Appl Surf Sci. 599 (2022) 153959.
[6] V. C. Teixeira et al., X-ray excited optical luminescence at Carnaúba, the Sirius X-ray nanoprobe beamline; Optical Materials: X 20, 100278 (2023).

I plan to submit also conference proceedings

No

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