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# Probing battery interfaces through free electron laser pulses

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Subpicosecond intense pulses delivered by extreme ultraviolet and soft x-ray free electron lasers (FEL) have been recently found to trigger second harmonic generation (SHG) from surfaces and interfaces in simple materials. Those disruptive pioneering experiments suggest that nonlinear spectroscopies could be a valid approach to monitor the atomic structure of selected interfaces in all solid state ion batteries [1].

An overview on FEL SHG pilot experiments carried out at the FERMI FEL in Trieste (beamline EIS-TIMEX) is presented [2,3], analyzing current limits and promising features of the approach. Theoretical principles are discussed that govern nonlinear optics and explain the potential sensitivity of SHG techniques to nanometer interfaces in multilayered materials.

Synergies between FEL beamlines, theoretical simulation groups and research teams involved in ion batteries development might be established to explore soft x-ray nonlinear spectroscopies and foster their use in battery research.

[1] E. Principi, Journal of Physics: Energy, 2023 (submitted)

[2] Lam R.K. et al., Physical Review Letters, 2018, 120, 023901. DOI: 10.1103/PhysRevLett.120.023901

[3] Schwartz C.P. et al., Physical Review Letters, 2021, 127, 096801. DOI: 10.1103/PhysRevLett.127.096801

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