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# High-Repetition-Rate X-ray Diffraction of Shock-Compressed PET at the EuXFEL

*Mittwoch, 28. Januar 2026 17:00 (1 h 30m)*

Dynamic compression of carbon-rich materials provides a pathway to nanodiamond formation [1-3] under extreme pressure–temperature conditions comparable to those of ice-giant interiors, where diamond precipitation has been proposed to influence planetary structure and evolution. Laser-driven shock experiments at x-ray free-electron lasers enable in situ, time-resolved characterisation of high-energy-density states. Such experiments are often limited by the need to accumulate large numbers of shots, particularly for photon-hungry techniques such as meV inelastic x-ray scattering. To address this limitation, the newly commissioned high-repetition-rate tape target system at the European X-ray Free-Electron Laser (EuXFEL) can be operated at 1 Hz, enabling unprecedented data acquisition. Beyond fundamental studies, high-repetition-rate dynamic compression represents a critical step towards scalable nanodiamond production schemes.

Using this platform, we present results on the characterisation of the shocked state of polyethylene terephthalate (PET), a readily available and easy-to-handle carbon-rich planetary-ice analogue, compressed via single-shock laser drive. Simultaneous x-ray diffraction (XRD) and Doppler velocimetry (VISAR) diagnostics were employed to characterise atomic-scale structural changes alongside macroscopic shock properties on the same experimental shots. A method based on the Rankine–Hugoniot relations, together with PET Hugoniot data, was used to determine the bulk pressure, density, and temperature directly from the measured shock velocity. The results provide evidence for diamond formation at pressures on the order of 60 GPa and corresponding temperatures of a few thousand kelvin, potentially extending the diamond formation regime reported by He et al. [2].

References:

[1] Kraus, D. et al.: Formation of diamonds in laser-compressed hydrocarbons at planetary interior conditions, Nat. Astron. 1, 606–611 (2017).
[2] He, Z. et al.: Diamond formation kinetics in shock-compressed C–H–O samples recorded by small-angle X-ray scattering and X-ray diffraction, Sci. Adv. 8(35), eabo0617 (2022).
[3] Heuser, B.: Synthesis of Nanodiamonds via
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Precursors, PhD Thesis, University of Rostock (2025).

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**Sitzung Einordnung:** Poster Session 2