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Table-top Generation and Spectroscopic Study of ∼10 TPa High-Energy Density Materials with C_{60}^{+} Hypervelocity (v ∼ 100 km/s) Impact[1]

YOUNG BAE, Y.K. Bae Corporation — Intense bursts of soft x-rays were discovered by Bae et al. in hypervelocity (v ∼ 100 km/s) impact of bio and water nanoparticles at the Brookhaven National Lab (BNL) in 1994. In the experiment, the nanoparticles were directly impacted on and detected by Si particle detectors that also detected the soft x-rays. Energy deposition measurements through thin films revealed that the impact generated pressures were ∼10 TPa, and the photon energies in the range of 75-100 eV for Si targets. The conversion efficiency from the kinetic energy to the radiation energy was unexpectedly high, ∼38%, which was attributed to Dicke Superradiance of collective quantum states in High-Energy Density Materials (HEDM), Metastable Innershell Molecular States (MIMS). This talk presents recent experimental results obtained in a table-top apparatus completely different from and orders of magnitude smaller than that at BNL. In the new setup, hypervelocity (v 100 km/s) C60+ ions impacted on Al targets, and the impact generated soft x-rays were detected off-axis and analyzed using three Si photodiode detectors with selective energy response curves. The photon energy was determined to be ∼70 eV with the kinetic-energy to photon-energy conversion efficiency of ∼35% in confirmation of the results by Bae et al. at BNL. The present results demonstrate a new way of generation and spectroscopic study of HEDM with pressures exceeding 10 TPa, and show the pathway to scaling up the soft x-ray generation method for a wide range of applications from lithography to inertial fusion.

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