Contribution ID: **99** Type: **Poster**

Overview on the target fabrication facilities at ELI-NP and the ongoing strategies.

Wednesday, 7 September 2016 10:45 (20 minutes)

Along with the development of petawatt class laser systems, the interaction between high power lasers and matter flourished an extensive research, with high-interest applications like: laser nuclear physics, proton radiography or cancer therapy. The new ELI-NP petawatt laser facility, with 10PW and ~10 23W/cm2 intensity, is one of the innovative projects that will provide novel research of fundamental processes during light-matter interaction(1). As part of the ELI-NP facility, Target Laboratory will provide the means for the in-house manufacturing (using UHV deposition system, RIE, optical lithography) and characterization (XRD, AFM, SEM, EDS etc.) of the required targets for the experiments, in addition to the research activity carried out in order to develop novel target designs for improved performances.
Recent advances showed that maximum proton energy can be significantly improved through target design optimization: using micro-structured front side surface(2) (nanospheres, nanowires, gratings), more complex target shapes(3) or by using a near-critical plasma layer on the irradiated side of the target(4). In the latter case, it was observed that the strongest self-focusing of the laser pulse occurs in near-critical density regime and the absorption takes place within the entire plasma volume. Carbonaceous nanostructured materials, like carbon nanotubes foam (CNF), are an adequate solution due to their low-density (< 10mg/cm3), but they have hardly been explored so far in a target assembly(5).
In view of the latest progress, one of the proposed strategies is to use DLC (diamond-like carbon) as an ultrathin foil, coated with VCNTF (vertically aligned carbon nanotubes foam) as low-density nanostructured layer. The carbon foam which behaves as a near-critical density plasma, absorb the prepulse and allow the controlled-shaping of the laser pulse, which undergoes relativistic self-focusing and temporal and spatial profile modulation. High-quality homogeneous CNT foam can be prepared, by enhanced plasma chemical vapor deposition technique, with a controlled thickness depending on the deposition time, and specific average density according to the feeding rate of catalyst and carbon source gas. As previously showed(6) CNT enhance the energy conversion (laser-energetic electrons) even if the spacing between the tubes is smaller than the laser wavelength, and despite the enhanced laser absorption, a smaller plasma expansion is observed on the CNT-target surface compared with a foil target.

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Session Classification: Poster Session