LIFT-ing carbon for high power laser applications

Maria Dinescu[1*], Mihail O. Cernaianu[2], Ionut Nicolae[1], Thomas Lippert[3,4], and Alexandra Palla-Papavlu[1]

[1]National Institute for Laser, Plasma and Radiation Physics, Atomistilor Street 409, Magurele, ZIP 07725, Romania
[2] IHIN-HH, ELI-NP, Reactorului 30, Magurele, ZIP 077125, Romania
[3] Paul Scherrer Institut, PSI Center for Neutron and Muon Sciences, Villigen PSI, Switzerald
[4] Department of Chemistry and Applied Biosciences, Laboratory of Inorganic Chemistry, ETH Zurich, Switzerald

[*]Corresponding author email: maria.dinescu@inflp.ro

Recent advances in laser-driven ion acceleration have highlighted he critical role of target materials in efficiently converting intense laser energy into high-energy ions for applications in nuclear physics and biomedicine. Among various approaches, mass-limited targets with finite transverse dimensions have shown promise towards enhancing ion acceleration, however, their fabrication, handling, and alignment remain technically demanding.
In this study, we demonstrate the use of laser-induced forward transfer (LIFT) to fabricate free-standing carbon "flyer" targets with well controlled thickness and lateral dimensions. Our method begins with the deposition of thin carbon donor films onto laser transparent substrates. A pulsed laser, incident through the substrate, selectively ejects these films into free space, creating isolated flyers. The ejection process is tracked in real time using time-resolved shadowgraphy, offering direct insights into the flyer formation dynamics.
By systematically varying the laser fluence, pulse duration and donor film properties, we establish reliable control over flyer morphology, achieving uniform geometry, low debris generation, and reproducible material characteristics.
We detail the key steps in donor film preparation, optimization of LIFT parameters and the influence of ambient versus vacuum environments. Additionally, we assess how the produced flyers fulfill the stringent demands of high-repetition rate laser systems, laying the groundwork for scalable, next-generation ion sources. This work positions LIFT as a versatile and low cost platform for advanced target fabrication in laser-plasma interaction studies.

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