Thin cryogenic hydrogen targets for laser-driven ion acceleration

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Target composition and geometry play a crucial role in laser-plasma interaction experiments. With the recent availability of large temporal contrast ratios at high power laser facilities the use of ever thinner targets becomes desirable. Simulations of new laser driven particle acceleration regimes exploiting these targets (e.g. radiation pressure acceleration (RPA) [1] and laser breakout afterburner (BOA) [2]) predict particle energies in the GeV range in contrast to tens of MeV achievable in present target normal sheath acceleration (TNSA) experiments.

In this contribution we will present our efforts to produce micrometer-sized cryogenic targets from pure hydrogen in foil-like geometry as well as polymer films with thicknesses of some hundred nanometers. While cryogenic hydrogen targets serve as pure proton sources and thus could provide very high proton energies, polymer targets with a carbon to hydrogen content ratio of 1:2 still provide high proton energies while being beneficial in terms of handling. According to particle in cell code (PIC) simulations both types of targets are expected to deliver laser driven particles with several hundred MeV per nucleon. Possible applications of these high energy particle beams include proton driven fast ignition [3] and the production of secondary particle beams such as neutrons [4]. Cryogenic hydrogen targets could also be used in high energy density experiments with swift ions produced by either lasers or conventional accelerators [5].

We will give an overview of target production and characterization at the Technische Universität Darmstadt as well as recently performed experiments at the PHELIX laser facility at the GSI Helmholtzzentrum für Schwerionenforschung GmbH. The project is supported by the Federal Ministry of Education and Research (BMBF) of the Federal Republic of Germany and the European High Power Laser Energy Research (HiPER) project.

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