Enhanced laser-plasma proton acceleration using solid foils with attached low density carbon foam

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In the interaction between a high power laser and a thin solid foil, the laser-plasma coupling can be strongly enhanced adding a low density material on the irradiated side, i.e. a carbon “foam”. We investigate by particle-in-cell simulations in two and three dimensions the role played by the density and the thickness of the plasma obtained from the ionization of the foam. The presence of a near-critical plasma strongly increases both the conversion efficiency and the energy of the “hot” electrons leading to enhanced acceleration of protons from a rear side as in a typical target normal sheath acceleration. A moderate self-focusing of the laser beam occurs during the propagation through the foam layer, suggesting an “enhanced” TNSA in the interaction with the solid foid. We found, however, that the electrons of the foam are strongly accelerated in the forward direction and, propagating on the rear side of the target, are the main responsible for building up a high electric field with a relatively flat longitudinal profile. In these conditions the maximum proton energy is up to three times higher than in the case of the bare solid target.

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[1] A. Sgattoni, P. Londrillo, A. Macchi and M. Passoni, “Laser ion acceleration using a solid target coupled with a low-density layer”, PHYSICAL REVIEW E 85, 036405 (2012)