Control of fast electron propagation in foam target by doping high-Z elements

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Fast electron propagation in foam target is studied by a newly developed hybrid particle-in-cell (PIC)/fluid simulation code named HEETS. The code employs an explicit time-stepping approach, treats the fast electrons by a standard, relativistic PIC method (including scattering and drag by the background plasmas), and models the background plasma as a collisional fluid. The electric field and background return current are calculated by Ohm's law and Ampere's law without displacement current, respectively. The background temperature is updated by Ohmic heating and collisional heating between fast electrons and background electrons, as well as the heat conduction is also included.

It is found that the target ionization is increased as it is doped with high-Z elements, and the resistivity is decreased at lower temperature but increased as the target temperature is greater than ~50eV, leading to a more collimated fast electron beam in the doped targets. Furthermore, the energy deposition of the fast electrons in the doped targets is decreased, which is beneficial for applications that require long distance propagations of the fast electrons. The fast electron propagation can also be improved by increasing target density due to the fact that the self-generated magnetic field can have a sufficient time to grow in such targets. However, it is not helpful for the long distance propagation of fast electrons, which enhances the fast electron energy deposition in its path. The results here should be helpful for the applications of ultraintense laser-driven fast electrons.

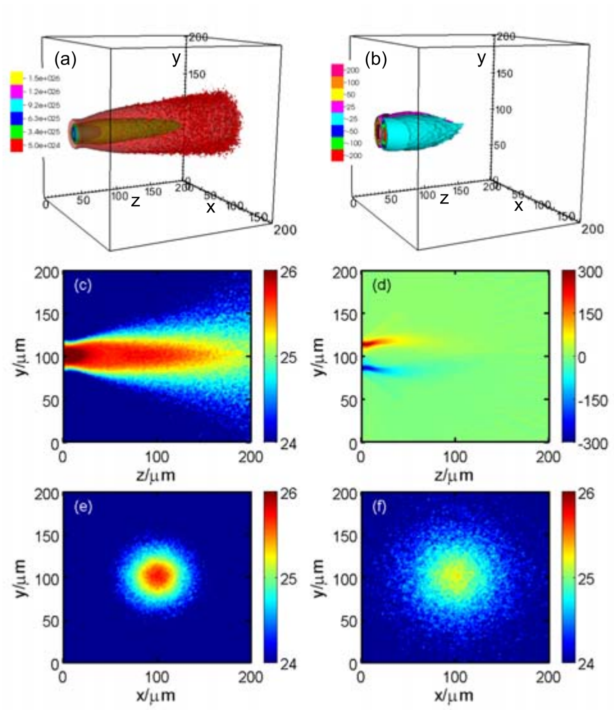

Figure 1 Distribution of log_{10} of fast electron density (a) and self-generated magnetic field B_x at t=1.3ps for a foam doped with 30% Br_2 with density 0.3g/cm^3. Corresponding distributions of fast electron density (c) and B_x (d) in the z-y plane, fast electron density at z = 100μm (e) and z = 180μm (f) in the x-y plane. The electron density and magnetic field are in units of m^{-3} and T, respectively.

References
(1) H. Xu, X. H. Yang, Control of fast electron propagation in foam target by doping high-Z elements, submitted.

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