Experiments and simulation on high-power laser irradiation of 3D-printed microstructures

M. Cipriani(1), A. Zurzolo(2), F. Consoli(1), M. Scisciò(1), R. Bonifetto(2), A. Froio(2), R. Testoni(2), P. Andreoli(1), G. Cristofari(1), E. Di Ferdinando(1), G. Di Giorgio(1)

(1) ENEA, Nuclear Department, C.R. Frascati, Italy

(2) Politecnico di Torino, Department of Energy, Italy

The research on Inertial Confinement Fusion (ICF) requires constant research for identifying new materials. Micro-structured low-density materials, or foams, with a randomly arranged internal structure, have been shown mitigate, to some extent, the detrimental effect due to hydrodynamic instabilities seeded by non-uniform irradiation, while also increasing the laser absorption efficiency and enhancing the pressure at the shock front. Laser 3D printing represents the new way of obtaining foams with precisely controlled morphology, gradients in density and pore size and sample shapes which would be challenging to make with other techniques.

In this presentation we will discuss recent experimental results obtained by high-power laser irradiation of 3D-printed plastic porous materials manufactured using the two-photon polymerization technique. The irradiations were performed at the ABC laser facility at ENEA Centro Ricerche Frascati, at the fundamental wavelength and at intensities ranging from 10^{14} W/cm^2 to about 10^{15} W/cm^2, relevant for ICF [1]. We will also present the results of a simulation work which is still ongoing to investigate the influence of the structural parameters of the materials on the plasma evolution. The simulations were performed with the FLASH code in 3D on the ENEA CRESCO8 High Performance Computing cluster in ENEA Centro Ricerche Portici. The simulations show a good agreement with the experimental data from the previous campaign. Particle-In-Cell (PIC) simulations were also conducted to investigate the thermalization of the plasmas filling the pores, generated by the ablation of the filaments constituting the material. This will lead to more robust and reliable modeling of the foam plasma homogenization, crucial for future target designs.

References

[1] M. Cipriani et al., accepted on Matter and Radiation at Extremes.

Acknowledgment

This work has been carried out within the framework of the EUROfusion Consortium, funded by the European Union via the Euratom Research and Training Programme (Grant Agreement No 101052200 — EUROfusion). Views and opinions expressed are however those of the author(s) only and do not necessarily reflect those of the European Union or the European Commission. Neither the European Union nor the European Commission can be held responsible for them.