MeV-level multi-charged ion generation in relativistic laser plasma based on gas clusters

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Laser-driven ion acceleration is a rapidly developing field with significant potential for creating compact sources of charged particles for applications in medicine, materials science, and fundamental research [1]. We compared Kr, Ar, and O_2 clusters for the generation of multi-charged ions with MeV energies under irradiation by a relativistically intense Ti:Sapphire laser pulses ($I \approx 5\times10^{18}$ W/cm^2) [2]. It was found that for krypton, the optimal average cluster diameter is about 30 nm (pressure $\approx$ 10 bar), yielding a maximum output of ions with energies of 1-3 MeV and charge states of 2+ to 5+. It can be assumed that the limited observed ionization states are due to recombination during the expansion of multi-charged ions. Home-built magnetic deflection time-of-flight spectrometer allowed estimating the Kr^{2+} ion flux up to 1.4×10^8 ions/(sr·pulse). The obtained results are important for the development of compact accelerated ion sources for applications in radiography, implantation, and studies of fast processes.

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