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Liquid crystals for high repetition rate targetry for laser driven ion acceleration

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Practical application of laser based ion acceleration will require advances across a wide range of technologies extending from the laser system itself to the delivery of the ion beam. We have recently shown that the liquid crystal 8CB provides an effective and relatively inexpensive new approach to target and plasma mirror fabrication and insertion for ion acceleration. 8CB is primarily hydrogen and carbon and forms in layers approximately 3 nm thick in its smectic phase. Taking advantage of these properties, we have developed a device we call the Linear Slide Target Inserter (LSTI) that can form films in situ from under 10 nm in thickness to over 50 um. I will describe this new technology and its operation as a target inserter and as a high-power plasma mirror. For proton acceleration, the LSTI readily achieves energies of 25 MeV using pulses of only a few joules by tuning the target thickness for the specific laser pulse characteristics and pre-pulse contrast. For plasma mirrors, we have demonstrated a weak field reflectivity below 0.2% and a high field reflectivity above 75%, yielding a pulse contrast improvement over two orders of magnitude. The LSTI can form films at a rate of several per minute for the thinnest films and we have also developed a prototype based on a new design that has demonstrated an effective film formation rate above 1.5 Hz for very thin films under 100 nm. I will discuss the current limits of our approach and conclude with our plans and prospects for improving this capability to the level needed for practical application using ELI class laser systems.

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