Transient plasma photonic crystals for high-power lasers

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Photonic crystals are one- or multi-dimensional periodic structures with periodicity length of the order of an optical wavelength. Photonic band structures are analogues to electronic bands, also showing frequency bands (photonic bandgaps) of inhibited optical modes. Research work on solid state photonic crystals started several decades ago and developed into a wide field of applications, ranging from Bragg mirrors, dispersive elements to nonlinear structures in which light is controlled by light [1,2,3].

Here we present a new type of transient photonic crystals for high-power lasers. The crystal is produced by counter-propagating laser beams in plasma. Trapped electrons and electrically forced ions generate a strong density grating, where the peak plasma density can be even in the overdense regime. The life-time of the transient photonic crystal is determined by ballistic motion of ions [4,5]. The robustness of the photonic crystal allows manipulation of high-intensity laser pulses. The scheme of the crystal is analyzed by 1D Vlasov simulations. Reflection or transmission of high-power laser pulses is predicted by particle in cell (PIC) simulations. It is shown that a transient plasma photonic crystal may act as a tunable mirror for laser pulses up intensities of $10^{17}$ W/cm$^2$ and down to pulse durations of a few tens of fs [6]. Generalizations to 2D and 3D configurations are possible, which open up the possibility for novel photonic structures in the context of ultra-high power laser radiation.