FROM LOW-INTENSITY EXPOSURES FOR PHOTONICS AND OPTOACOUSTICS TO INTENSE ULTRASHORT HARD X-RAYS

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Structured optically thick films are considered for applications in telecommunications and nanosensing. Thanks to structure, these films transmit light [1] thus acting as a photonic device. At the same time, the film remains an effective transducer of terahertz sound generators in the film and substrate [1]. Thus our device combines the properties of photonic and optoacoustic devices. The films are created by magnetron sputtering inside few Pa Argon atmosphere.

Sub-picosecond optical laser processing of metals is actively utilized for modification of a heated surface layer. But for deeper modification of different materials a laser in the hard x-ray range is required. Here, we demonstrate that a single 9-keV x-ray pulse from a free-electron laser can form a μm-diameter cylindrical cavity with length of ~1 mm in LiF surrounded by shock-transformed material [2]. The plasma-generated shock wave with TPa-level pressure results in damage, melting and polymorphic transformations of any material, including transparent and non-transparent to conventional optical lasers. Moreover, cylindrical shocks can be utilized to obtain a considerable amount of exotic high-pressure polymorphs. Pressure wave propagation in LiF, radial material flow, formation of cracks and voids are analyzed via continuum and atomistic simulations revealing a sequence of processes leading to the final structure with the long cavity. Similar results can be produced with semiconductors and ceramics, which opens a new pathway for development of laser material processing with hard x-ray pulses.

Литература

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