Highlights

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Laser ablation and structuring of CdZnTe with femtosecond laser pulses

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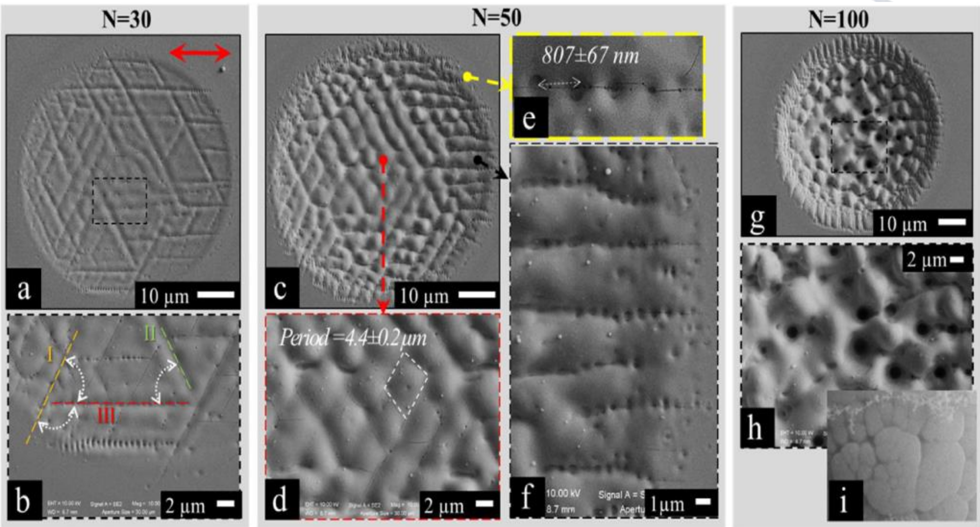
We report an experimental investigation on laser ablation and associated surface structuring of CdZnTe by femtosecond Ti:Sa laser pulses (laser wavelength λ≈800 nm, ≈35 fs, 10 Hz), in air. By exploiting different static irradiation conditions, the fluence threshold and the incubation effect in CdZnTe are estimated. Interestingly, surface treatment with a low laser fluence (laser pulse energy E≈5-10 μJ) and number of shots (5≤ N ≤50) show the formation of well-defined cracks in the central part of the shallow crater, which is likely associated to a different thermal expansion coefficients of Te inclusions and matrix during the sample heating and cooling processes ensuing femtosecond laser irradiation. Irradiation with a larger number of pulses (N≈500, 1000) with higher pulse energies (E≈30-50 μJ) results in the formation of well-defined laser-induced periodic surface structures (LIPSS) in the outskirts of the main crater, where the local fluence is well below the material ablation threshold. Both low spatial frequency and high spatial frequency LIPSS perpendicular to the laser polarization are found together and separately depending on the irradiation condition. These are ascribed to a process of progressive aggregation of randomly distributed nanoparticles produced during laser ablation of the deep crater in the region of the target irradiated by a fluence below the ablation threshold with many laser pulses.



SEM images of CdZnTe after irradiation with a sequence of various number of pulses N, at E = 5 μJ and corresponding zoomed views: (a, b) N = 30; (c-f) N = 50; (g-i) N = 100. The red arrow in panel (a) indicates the laser polarization direction. In the zoomed view of panel (b) cracks directed along three different directions are indicated and termed as type I, II, and III. Panel (d) shows the central region of the spot displayed in panel (c) evidencing periodic bumps separated by cracks, while periodic arrays of subwavelength holes formed close to the spot edges are shown in panels (e, f). The zoomed view of panel (h) addresses the columnar features formed at the center of the spot for N = 100.