Femtosecond laser induced periodic surface structuring of Bi_2Te_3 crystal

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Bi_2Te_3 is a topological insulator (TI) crystal belonging to a class of materials with peculiar properties when reduced at low dimensions [1]. Femtosecond (fs) laser irradiation of solid targets is particularly interesting for the fabrication of functional materials with structures surfaces, but this topic is still scarcely investigated for TI. Here we report on femtosecond laser irradiation and surface structuring of a bismuth telluride (Bi_2Te_3) crystal. The laser pulses are provided by a Ti:Sa laser source (~800 nm, ~35 fs) operating at a repetition rate of 100 Hz. The target is cleaved from a Bi_2Te_3 single crystal grown in a floating zone image furnace. The laser beam is focused on the target surface by a plano-convex lens at normal incidence. The morphological features of different spots produced on the target surface have been analyzed by using a field emission scanning electron microscope (FE-SEM). Interestingly, laser induced periodic surface structures (LIPSS) form at the peripheral region or in the tail of the Gaussian spot but are absent in the central region of the spot irradiated at higher fluence [2]. This very peculiar morphology of the shallow craters is investigated for different sequences of N laser pulses ($1 \leq N \leq 1000$) at different pulse energies E_p ($3\ \mu J < Ep < 60\ \mu J$). To our knowledge, this is the first report on the formation of fs LIPSS on topological insulators. In addition, we will also discuss the effects of the number of laser pulses, pulse energy and laser polarization on the morphological features of irradiated target surface. The possible effects of material phase change or surface oxidation on irradiation with fs pulses are also considered to find a correlation with the annular shaped crater formation in Bi_2Te_3.

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