Highlights

Light-matter interaction and non-equilibrium dynamics in advanced materials and devices - 2018

Surface structures with unconventional patterns and shapes generated by femtosecond structured light fields

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An investigation on ultrashort laser surface structuring with structured light fields generated by various q-plates is reported. In particular, q-plates with topological charges q = 1, 3/2, 2, 5/2 are used to generate femtosecond (fs) vector vortex beams, and form complex periodic surface structures through multi-pulse ablation of a solid crystalline silicon target. We show how optical retardation tuning of the q-plate offers a feasible way to vary the fluence transverse distribution of the beam, thus allowing the production of structures with peculiar shapes, which depend on the value of q. The features of the generated surface structures are compared with the vector vortex beam characteristics at the focal plane, by rationalizing their relationship with the local state of the laser light. Our experimental findings demonstrate how irradiation with fs complex light beams can offer a valuable route to design unconventional surface structures.

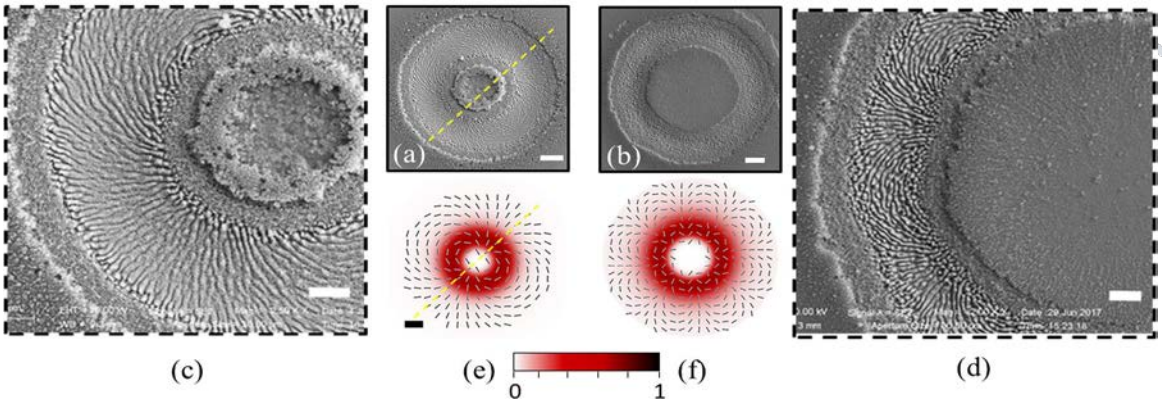

Fig. 1: Panels (a) and (b): Example of SEM images showing the morphologies on the silicon target after an irradiation sequence of N=200 pulses in tuned condition of q-plates (δ=π), for (a) q=1, and (b) q=5/2, respectively. The pulse energy is E_0=50 μJ for q=1 and E_0=100 μJ for q=5/2. Panels (c) and (d) display zoomed views of the SEM image. The scale bars in SEM images are 20 μm for (a) and (b) and 10 μm for (c) and (d). Panels (e) and (f) report simulation of far-field beam profile with local direction of the beam polarization. The yellow dotted line in panel (a) marks a direction along which grooves alignment closely resembles a quasi-radial pattern, while in panel (e) it shows the corresponding line in the state of polarization (SoP) of the beam. On either sides of this dotted lines, the surface structures and SoP of the beam are arranged as a family of spiral-like patterns.