Highlights

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

Simple method for the characterization of intense Laguerre-Gauss vector vortex beams

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Complex light beams with non-Gaussian intensity profiles and spatially variant state of polarization are becoming more and more attractive in many fields of optical science and technology. In this context, the progressive development of efficient beam converters is offering the possibility of generating powerful, pulsed optical vortex (OV) and vector-vortex (VV) beams, thus permitting experiments with such structured light beams with the aim of observing new experimental features in emerging applications, e.g. laser processing and surface structuring,. The local state of a laser beam (e.g., fluence and polarization) can strictly influence the laser-induced modifications (e.g., melting, phase transformation, ablation, features of the surface structures engraved on the material, etc.). Hence, the need of a careful characterization of the beam properties in order to unveil the mechanisms involved in several laser-induced material transformation processes. For intense Gaussian laser beams, a direct method to characterize the beam spot size is based on the variation of modified area vs laser energy; such a method is generally used in experiments with intense beams. In this study, we have illustrated a direct experimental technique based on the analysis of laser ablation spots allowing to characterize the properties of intense, OV and VV beams with femtosecond pulse duration, in weak focusing conditions. In particular, we have discussed various ways to gather an estimate of the beam spot size as well as the state of polarization by means of the analysis of the laser-induced surface structures orientation. The method was applied to silicon, but the approach can likely be extended to other materials or to still more complex VV beams.

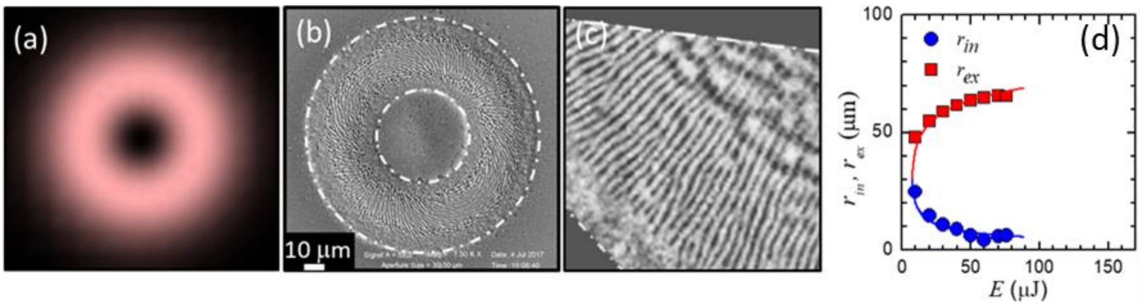

Fig. 1: (a) typical annular profile of a VV beam; (b) shallow ablation crater generated on a silicon plate by a VV beam – the inner part of the crater is decorated by laser induced periodic surface structures whose orientation is directly linked to the local direction of the laser beam polarization; (c) zoomed view of the surface structures; (d) variation of the inner and outer crater radii as a function of laser pulse energy E, from which the laser beam spot size is derived by means of a fitting procedure (solid lines).