Generation of Optical Vortices via Electro- and Piezo-Optic Effects in Ferroelectric-Type Crystalline Materials

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The aim of this work is to report the recent achievements in generation of optical vortices that bear an orbital angular momentum, using the crystalline materials subjected to inhomogeneous electric fields and mechanical stresses [1–6]. It is shown that the optical vortices with different topological charges can be generated as a result of the following factors: (i) the torsion and bending stresses, via the piezo-optic effect, (ii) the 'conically' shaped electric fields, via the Pockels and Kerr electro-optic effects, and (iii) the acousto-optic diffraction in crystals possessing the optical activity effect. The conditions of generation of the optical vortices are analyzed for the crystals of different point symmetry groups. The singularities of optical wave fronts and the induced optical vortices are revealed experimentally for a number of crystalline materials. The efficiency of optical vortices generation is analyzed for different crystalline materials. It is found that the ferroelectric crystals are among the most efficient materials used for this aim (see [7]). The results obtained are discussed, considering the fact that the angular momentum linked to optical beams represents one of their fundamental properties, which have been widely studied in the recent years. There is a great interest in 'spinning' and 'twisting' of light as manifestations of the two rotational degrees of freedom of any photonic flux, in the spin and orbital angular momentums associated with the quantum properties of light. They can be used in a number of novel areas of application, e.g. information processing, quantum cryptography, quantum teleportation, manipulation of microparticles and creation of non-diffractive beams [8].

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