Polarization dependence of femtosecond laser induced circular birefrigence in silica glass

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Abstract

From a practical point of view, femtosecond-IRlasers can now generate pulses with ultra-high intensity of tera or even peta W/cm2. This kind of laser leads to radically different laser–matter interaction from that achieved with a conventional laser. Highly non-linear multiphoton processes are observed, so even transparent material can absorb this light when the intensity is high enough. This allows 3D direct writing when the beam is strongly focused into transparent materials, particularly silica-based glasses. The mechanism of interaction of the femtosecond laser light with dielectric materials is not fully understood but one recognized specificity due to the very small pulse duration is that the action of the light on electrons and ions is decoupled. Then, by choosing the correct configuration of the beam for controlling the ponderomotive force, we can imagine forcing the electrons to move to one side of the beam, creating an inhomogeneous plasma. This may be the clue to an innovative aspect in materials science. Many recent works on pure silica have been conducted, and several properties have been demonstrated in this glass: average index changes, linear birefringence LB and linear dichroism LD. We recently revealed a chiral mechanical structure by measuring the surface topography of laser tracks written in opposite directions that could lead to circular properties. Taylor reported highly ordered chiral-like nanostructures using circular polarized laser light but no circular optical properties. We recently report on the creation of circular optical properties and non-reversible measurements according to the probe face. Here it is shown that by controlling the laser-writing configuration, we can create a quite high ellipticity of 40deg/mm revealing the creation of a large circular dichroism (CD), a useful range for potential applications. As the writing polarization is adjustable from 0 to 360∘, the ellipticity maximum appear for linear polarization oriented at 112∘ and 292∘. In addition, ellipticity measurements are non-reversible (the values are different when change the light propagation). This is due to the co-existence of anisotropic LBLD, which exhibit a different spatial distribution from the CD.

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