Photoinduced self-assembly of nanostructure

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Since the discovery of the laser-induced periodic surface structure (LIPSS) by Birnbaum nearly a half-century ago, many interesting researches have been carried out from the experimental and theoretical perspectives. As opposed to the LIPPS on the various materials (metal, semiconductor, dielectrics), bulk nanogratings inside of the material were found only for handful materials. Although such polarization-dependent bulk nanograting structure is one of the intriguing structure induced by the femtosecond laser pulses, the formation mechanism of bulk nanogratings is also still a mystery. As shown in Fig. 1, the photoinduced bulk nanogratings can be empirically classified into the following three types: (1) structural deficiency, (2) compressed structure, (3) partial crystallization. In the case of silica glass, the periodic nanostructure indicates localized form birefringence inside isotropic material. Interestingly, the stripe-like domains consisting of the strained and densified crystal phase were self-assembled parallelly to the laser polarization in the case of indirect bandgap semiconductors. More recently, we have also confirmed that in the case of Al_2O_3-Dy_2O_3 glass, the periodic nanostructures induced by the glass-crystal transformation in the direction perpendicular to the laser polarization. In the presentation, we will introduce the formation mechanism of bulk nanograting structure and its application.

Fig. 1 Polarization-dependent nanostructure in various materials