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Direct laser writing of self-organized nanograting for volume reflective color pixels in nanoporous glass

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We developed a technology for volume color reflection pixels in nanoporous glass (NPSM). This technology is based on direct laser writing (DLW), focused laser (λ =515 nm, P = 83 W, ν = 200 kHz,τ = 220 fs) used to obtain high laser intensity for refractive index modification of NPSM. Green reflection pixels can be observed under the microscope reflection mode. After impregnation of distilled water, the reflective color changes to red. The geometric shapes and spectrum have been tested.

Introduction. DLW has been widely used in the field of optical waveguides, sensors, microfluidics and augmented reality. Among them, augmented reality (AR) has developed a lot in recent years for displaying. Inside elements are more resistant to wear and tear, like volume holographic grating (VHG) and polarization volume grating (PVG), which have been integrated in the main part of AR glasses. In our research, we present a volume phase grating (VPG) integrated in NPSM by DLW. This kind of VPG contains lots of color pixels inside. Under the irradiation of mixed light, the VPG shows the green color reflection into some specific angle (~80º). When the VPG impregnated with distilled water, it was found that the color changed into red. We consider the reason for this is that self periodic organization gratings, that is type II refractive index modification of glass. The reflection and transmission spectrum were also tested. The reflection peak appeared in the range of 513 nm - 537 nm. And there is also an obvious difference for the transmission curve in the range of 504 nm - 529 nm from pure NPSM. Besides We have successfully projected an image on the VPG that can work as a screen. These findings show that VPG with color pixels in NPSM has the potential to be a new component of AR display devices.

Method. This kind of pixel can be simply fabricated in a DLW system, which contains a fiber laser source (Avesta Ltd. ANTAUS-20W-20u/1M), three dielectric mirrors, an objective (20X, NA = 0.4, LOMO ltd.) and a coordinate stage (Thorlabs, DDSM50/M). A NPSM with average pore diameter size of 17 nm was irradiated by 515 nm focused laser (P = 83 W, ν = 200 kHz,τ = 220 fs). At the focal point of the objective, the pixels with diameters d = 3 ± 0.5 formed. Under the reflective mode of the microscope, green color reflection was found. By dropping water, the color is able to change to red.

Conclusion. The technology of laser induced color pixels for VPG in NPSM has been developed. The reflection color pixels (green and red) have been successfully fabricated with the available resolution of 3 μm. We suggest the pixels consist of screen work in the field of AR.

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