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Color glass marking technology: results and implementation

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In this work, we study the color formation on glass surface by LIMP when the donor material is a multicomponent one such as a brass plate. As a result, 4 colors and the corresponding shades were obtained and the resolution of the marks is 30-50 μm.

Introduction. The optical properties modification of glass is of high significance for industry as well as photonics. The promising way is indirect laser techniques e.g. laser-induced micro plasma (LIMP). Basically, it operates at two regimes, when plasma action (with high T ~ 14000 K) ablates glass surface with high precision (± 50 nm) to fabricate phase elements, and lower plasma temperature when donor particles are deposited on a glass backside. In this case thermochemical reactions lead to formation of the color palette on glass surface. The problem is to obtain several colors while using a single target material.

Main part. The method was applied on a commercial laser setup (TurboMarker, Laser center ltd.) based on nanosecond fiber laser (λ=1064 nm, P=20 W, ν=20-999 kHz and τ=4-200 ns, IPG-YLPM-1-4X200-20-20). Glass plate Levenhuk G50 of 1.0 mm thickness was placed on the surface of the brass plate (concentration wt. % 65 Cu, 34.2 Zn, 0.2 Fe, 0.1 P, 0.07 Pb, 0.005 Sb, 0.002 Bi and 0.05 impurities). Nanosecond laser pulses were focused on the interface plane of the brass and glass. The focus zone was scanned with a galvanometric scanning system. A telecentric lens with a focal length f = 102 mm and a processing area of 110 mm^2. The laser beam has a Gaussian distribution and focal spot diameter of 50 μm.

As a result, a polychromatic amplitude mark was formed on the surface of the optically transparent material. In this step, the formation of 4 different colors was demonstrated. The characterization of the deposited marks was performed with reflection spectroscopy, with scanning electron microscopy the structure and composition of the surfaces were studied. In addition, the thickness of the deposited marks was determined, plasma spectrometry studies were performed and finally the durability of the marks was verified by immersing the samples in an ultrasonic immersion bath.

Conclusions. The technology of laser-induced high-resolution polychromatic mark formation on the surface of a glass substrate was developed. The recording resolution is 35 μm. The formation of 4 colors: green, yellow, red, gray using a single multicomponent material was demonstrated. Spectral and microstructural characterization of the deposited coatings was performed. Glass surface decoration applications are suggested, as well as the application of safety and traceability markings. In the future, the tasks of applying amplitude and phase information marks and increasing the efficiency of the method are proposed. The method is implemented in an industrial laser system, suggesting the possibility of introducing the method into production with subsequent process automation.

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