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Color Image Printing by Polymer-Assisted Photochemical Deposition

Background

Colorful pigments from pictures serve to selectively absorb light within a spectral range, thus modulating the light reflection and color display. Conventional pigments, however, are usually toxic and relatively large. They also tend to degrade over time and lose their brightness and resolution.

Structural color is an alternative to conventional pigments and makes use of micro- or nano-structured materials, such as plasmonic nanoantennas, metasurfaces, photonic crystals, or thin-film interferometers to modulate the light adsorption, scattering, and interference and accordingly display color. Structural color printings have attracted attention in recent years due to their advantages of long-term sustainability, eco-friendly manufacturing, and ultra-high resolution. However, most of them require costly and time-consuming fabrication processes including nanolithography, vacuum deposition, and etching.

Invention Description

Researchers at Arizona State University have developed a novel color 3D printing technology based on polymer-assisted photochemical metal deposition (PPD). The PPD process is room temperature, non-toxic, solution-based additive manufacturing process used to print metallic reflectors in a Fabry-Perot (FP) cavity.

This process is used to print ultrathin (~5nm) and smooth silver (Ag) films as the top absorptive reflector, as well as thick and reflective films as the back reflector. As a result, the printed metal-dielectric-metal microcavity structures exhibit vivid and saturated colors from blue to green and red on a variety of substrates, including glass, PDMS, and plastics. PPD is capable of directly structure writing with a spatial resolution down to 6.5 μm, which is comparable with current colorant-based color printing. The resolution can be further improved by improving the numerical aperture of the projection system to reduce the beam spot size on sample surface.

Potential Applications

- Anti-counterfeit labels
- Colorimetric sensors
- Flexible structural color membranes
- Decorations

Benefits & Advantages

- Accessible & inexpensive process

- Wide range of potential substrates (e.g., glass, PDMS, plastics)
- High spatial resolution (down to 6.5 μm)
- Vivid and saturated colors (high brightness and color purity)

Related Publication: "Printing Continuous Metal Structures via Polymer-Assisted Photochemical Deposition" | Materials Today, vol. 37, pp. 10-17, 2020.