The Application of Plasmonic Color filter to Display Devices: Plasmonic Chromatic-Electrode

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When an incident light encounters a metal structure on a sub-wavelength scale, free electrons of the metal collectively oscillate, and this oscillation propagates along the surface, as surface plasmons (SPs). SPs which are generated in nano-holes can enhance the degree of light transmission at the resonance frequency (or wavelength), and this is called extraordinary optical transmission (EOT): it is much higher than the estimation from classical optic theory, and larger than the opening ratio of the holes.[1] The resonance frequency can be adjusted by modifying the structural design (such as the periodicity, hole size, the thickenss of the metal, etc) and the optical constants of the materials. Selective transmission with metallic nano-holes in the visible range has been demonstrated as plasmonic color filters (PCFs), one of the structural color technologies. Due to their durability to light and the easy design-rules for tuning the filtering band, PCFs have emerged as an alternative to conventional color filters based on dye or pigment.

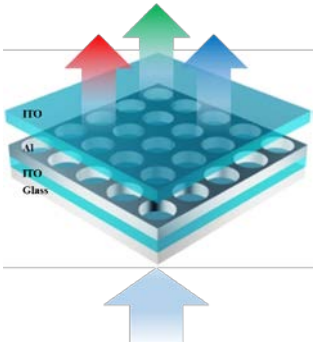

Fig. 1 Schematic of the plasmonic chromatic-electrode

We have also reported other studies on PCFs, including a PCF with a design method and fabrication for large area applications[2], and a PCF combined with transparent TFTs[3]. In the same vein, to the best of our knowledge, we here firstly present a novel plasmonic chromic-electrode (PCE) which also works color filter as well as an electrode with low resistivity. Fig 1 shows the structure of the suggested PCE. We used aluminum (Al) with high plasma frequency for the plasmonic material, and utilized indium-tin-oxide (ITO) for the conducting dielectric material. Finite-difference time-domain (FDTD) analysis was conducted to design a structure with the optimized optical property. The PCE fabricated by laser interference lithography showed red color with 32% transmittance. It also resulted in a sheet resistance of less than 2Ω/sq which is comparable to that of conventional electrodes. The proposed convergence of an electrode with a chromatic function could contribute to reducing the number of components and simpifying the structure of industrial imaging devices such as displays and image sensors.

References

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