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Research progress in plasmonic structural colors

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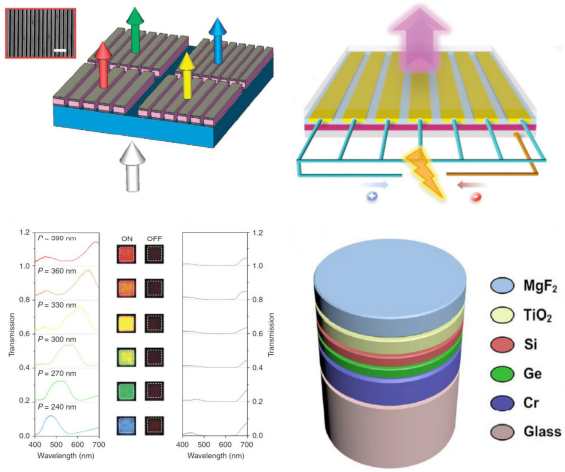

Schematic diagram of the proposed plasmonic nanoresonators.

Abstract: Perception of color with our eyes is one of the major sources of information that we gain from our surroundings. The color of an object depends on which portion of light (range of wavelengths) reaches our eyes. In nature, structural colors are often caused by the interaction of light with dielectric structures whose dimensions are on the order of visible-light wavelengths. For example, in beetles, the color is originated from the microstructure of the skin which is acting as scattering center; while in some butterflies, the colorful patterns are routed from the reflection from the top of the wings. Different optical interactions, including multilayer interference, light scattering and photonic crystal effect, give rise to selective transmission or reflection of particular light wavelengths, which leads to the generation of structural colors. With the consumption of dyes and pigments, recycling of colored discarded materials has been a very difficult issue because of the hardships in relation to the dissociation of diverse chemical compounds present in the colorant agents. Plasmonic colors therefore draw attention as they enable generation of vivid colors only by geometrical arrangement of metals which not only eases the recycling but also enhances the chemical stability of the colors. Plasmonic colors are structural colors that originate from the interaction between light and metallic nanostructures. Rapid development in nanofabrication and characterization of plasmonic structures provides an efficient way to control light properties at subwavelength scale, which can generate plasmonic structural colors. The engineering of plasmonic colors is a promising, rapidly emerging research field that could have a large technological impact. Artificial surfaces, in particular, on which the colors are generated via a resonant interaction between light and subwavelength metallic nanostructures, have emerged as nanomaterials or metamaterials for the realization of structural colors. Here we introduce several representative plasmonic nanostructures which can generate visible structural colors, including nanogratings, perforated metallic films, metal-insulator-metal resonators, dynamically tunable color generators and perfect absorbers. We highlight the properties of plasmonic colors and discuss the intrinsic plasmonic resonance mechanisms. Plasmonic structural colors have features of sub-diffraction localization, high-fidelity color rendering and rapid responses of external changes, which are believed to offer a promising future in the applications including ultra-high resolution color display, spectral filtering and sensing, holography, three-dimensional stereoscopic imaging and real-time colors controlling with extremely compact device architectures.

Keywords: plasmonics; color filtering; nanofabrication; metallic nanostructures

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