Synthetic Multi Spectral Metamaterials for Frequency Selective Terahertz-Color Filter

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Recently, the synthetic multi-spectral materials (SMMs) have attracted considerable attention in the multi spectral imaging system to maximize the spectral information density from terahertz to visible range [1, 2]. In this paper, we propose a novel SMMs by integrating terahertz meta-cavities and optical etalon structure and show that the terahertz (THz) and optical frequency of the proposed SMMs can be independently manipulated by their top and bottom layer displacement.

Fig. 1 shows the schematic design of the proposed SMM filter. The SMM filter consists of two spatially separated complementary cut-wires (CCWs), which exhibit both of transmittive resonance in the terahertz frequencies and visible color due to their etalon structure configuration. Fig. 1(b) and (c) shows the geometrical parameters of the CCW in the SMM filter: w = 20 µm, l = 80 µm, x = 80 µm, and y = 120 µm for various vertical layer displacement of t = 110, 140, and 180 nm and lateral layer displacement of s = 0, 10, 25 and 40 µm. Since the THz resonance frequency is determined by the lateral alignment between the CCW layers, while the visible color is determined by the vertical gap between the CCW based metal layers, we can expect that the proposed SMMs can independently manipulate their THz and visible frequencies in accordance with their layer-to-layer displacement direction.

Fig. 2 shows the measured THz-visible spectra of the proposed SMMs with vertical and lateral displacement between top and bottom CCW layers. The measured results successfully show that the proposed SMMs for various vertical displacements can manipulate their visible color with identical THz spectra, while the SMMs for various lateral displacements can manipulate their THz resonance frequency with identical visible color.

In conclusion, we proposed a novel SMM filters which can be fabricated by conventional large-area display fabrication and can independently manipulate their THz and visible frequency. Our proposed SMMs successfully integrated the THz and color filter and therefore pave the way to utilize the THz applications in the worldwide display industries.

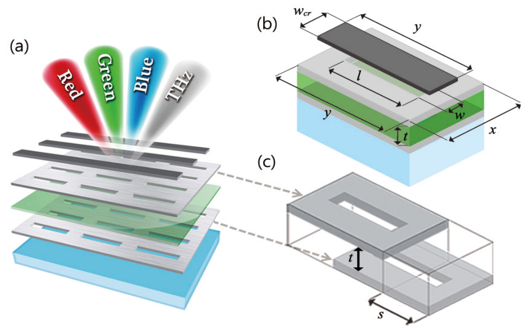

Fig. 1. (a) Schematics of the proposed SMM filter and (b-c) its unit cell structure

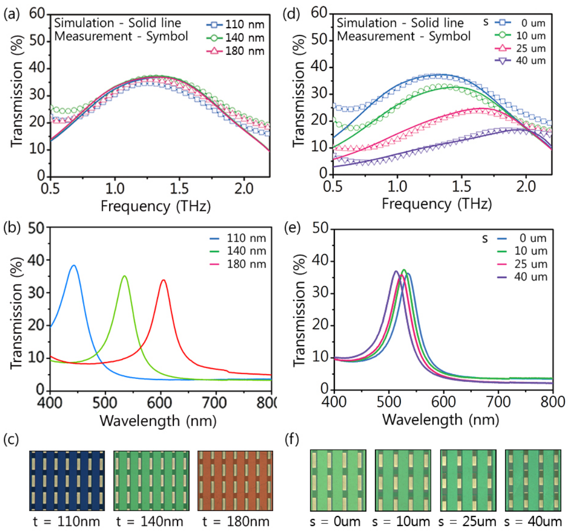

Fig. 2. THz and visible spectra with (a-c) thickness variation and with (d-f) lateral displacement

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