Supporting Information - Fourfold Color Filter Based on Plasmonic Phase Retarder

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Supporting Information including:
5 pages with 3 figures

1. Angle- and Direction Dependency of the Sample

Figure S1a shows a scheme of the different incident angles onto the sample. θ indicates the tilt angle, whereas Φ defines the rotation angle of the sample compared to the normal. To have highest angle-independency the transmission for varying tilt angles should be constant; this should also be fulfilled upon rotation and then tilt of the sample. Figure S1b shows the simulated transmission plot of the sample upon different tilt and rotation angles. The observed colors are indicated on the right side. For varying tilt angle the spectra remain relatively constant; accordingly the observed colors only show minor variance. Applying a polarizer onto the sample simultaneously creates p-pol and s-pol for rotation angles Φ=0° and Φ=90° (or *vice versa*). This leads to appearance of the same color from all directions and tilt angles depending only on the orientation of the polarizer.

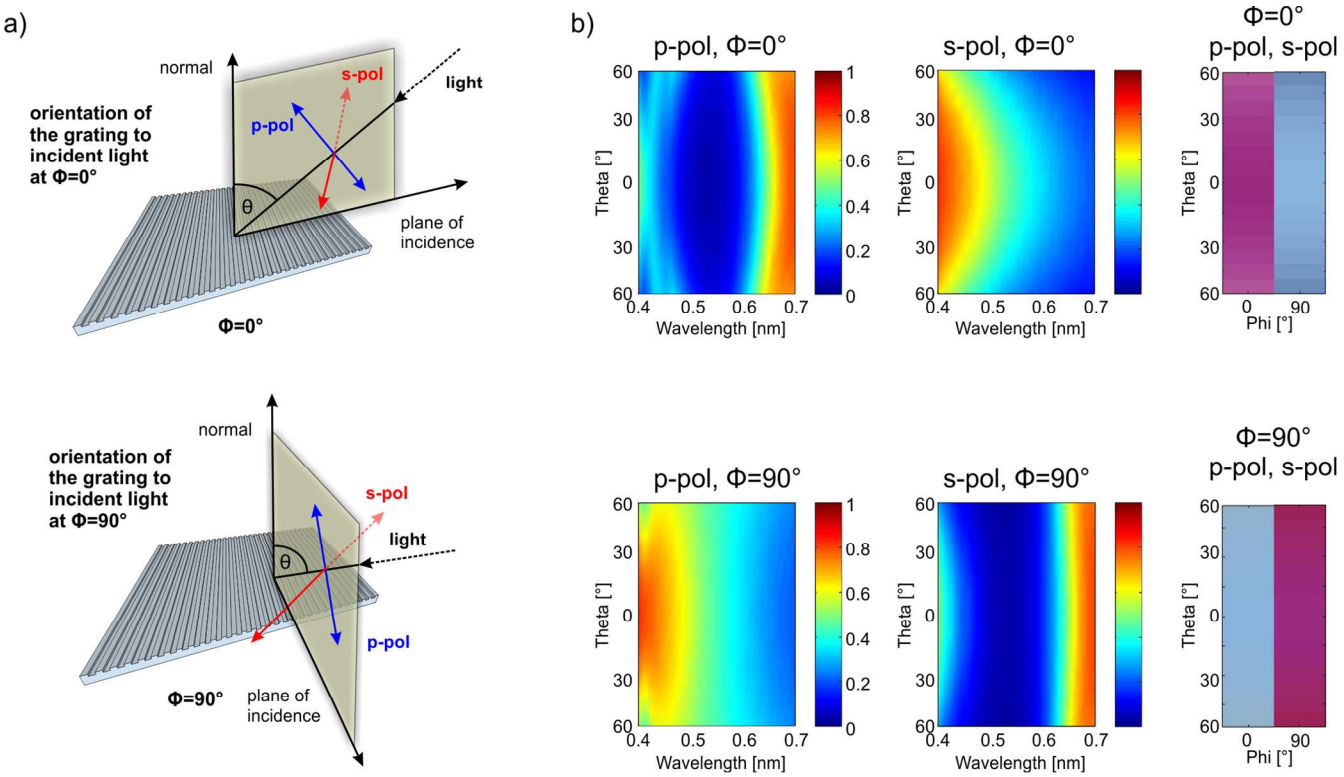

Figure S1: a) scheme of the measurement setup with the incident tilt angle θ and sample rotation angle Φ, the plane of incidence and the polarization s-pol and p-pol. b) Simulated transmission map of the sample upon different angles and the corresponding color. The angle-dependency is weak, especially for the appearing color.

2. Simulation of the Near-field Intensity and Charge Distribution

To further investigate the origin of the phase shift, we calculated the electromagnetic near-field and the electric charge distribution for different wavelengths (Figure S2a-c). Below the resonance (*) the electric field is localized near the upper layer of nanowires, as well as between the nanowires; it appears as if the light "funnels" through the nanowires (Figure 2a top). In this regime the wavelength is too short to resonantly excite plasmons on the nanowires. At the LSPR wavelength (λ_R) most light is reflected by the upper layer of nanowires (Figure 2b top). At even longer wavelengths (†), the resonance condition is no longer fulfilled and the transmission increases (Figure S2c top). The computations show that the LSPR moves the region of highest field enhancement from inside the nanowires to in-between the nanowires. Correspondingly, the distribution of charge shows a sign change (see Figure 2a-c bottom). Below the resonance a high charge density is present within the upper layer of nanowires, with the black arrows indicating the direction at a given time. At resonance a high charge density is present mainly in the upper layer, consistent with the near-field enhancement. Beyond the resonance the charge density of the upper and lower layer of nanowires are opposing each other.

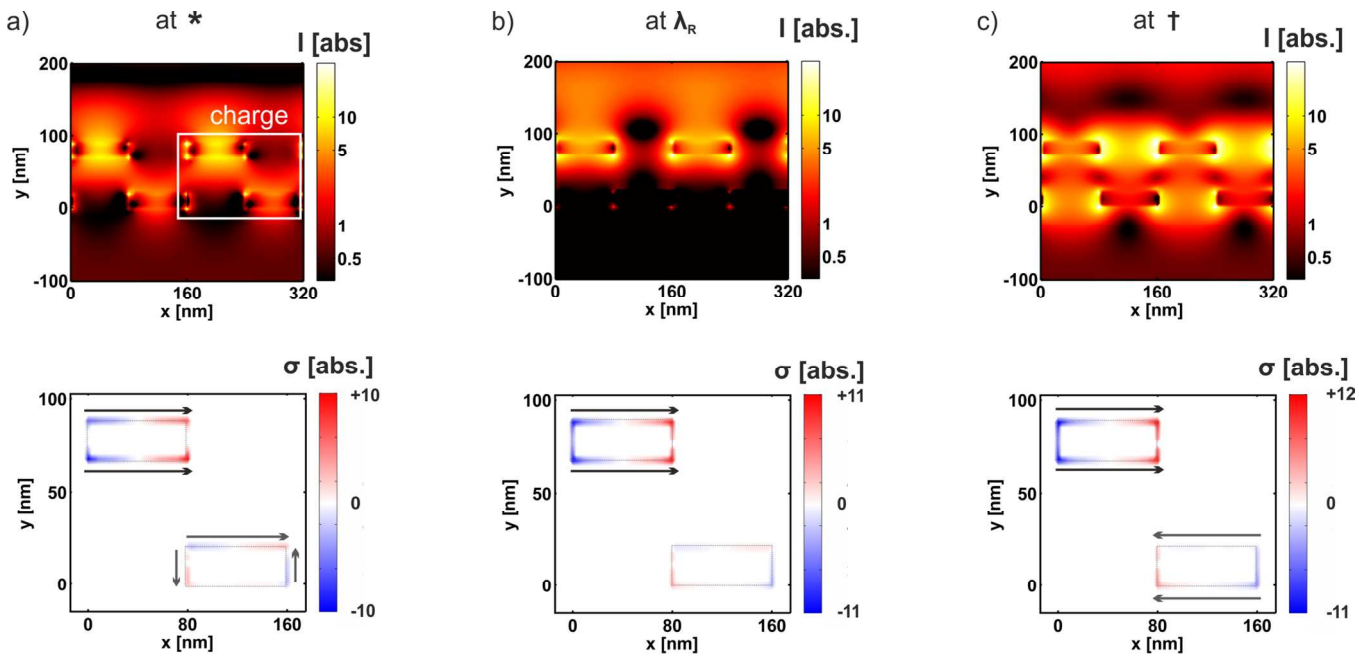

Figure S2. *(a)-(c) show the near-field and charge density respectively of the nanowires at the points indicated in Figure 3a,b. The black arrows indicate the direction of the electron flow at a given time. The black dashed lines outline the geometry of the simulated structure.*

3. Color Effect is strongly enhanced by LSPR induced phase shift

Figure S3 shows the influence of the induced phase shift on the color effect. The sample of Figure 5 is illuminated as described in Figure 1a and c respectively. Figures 3b,d display this effect in a CIE color plot with the measured sample of Figure 1. Clearly the high contrast colors only appear upon the use of the second polarizer utilizing the proposed phase shift.

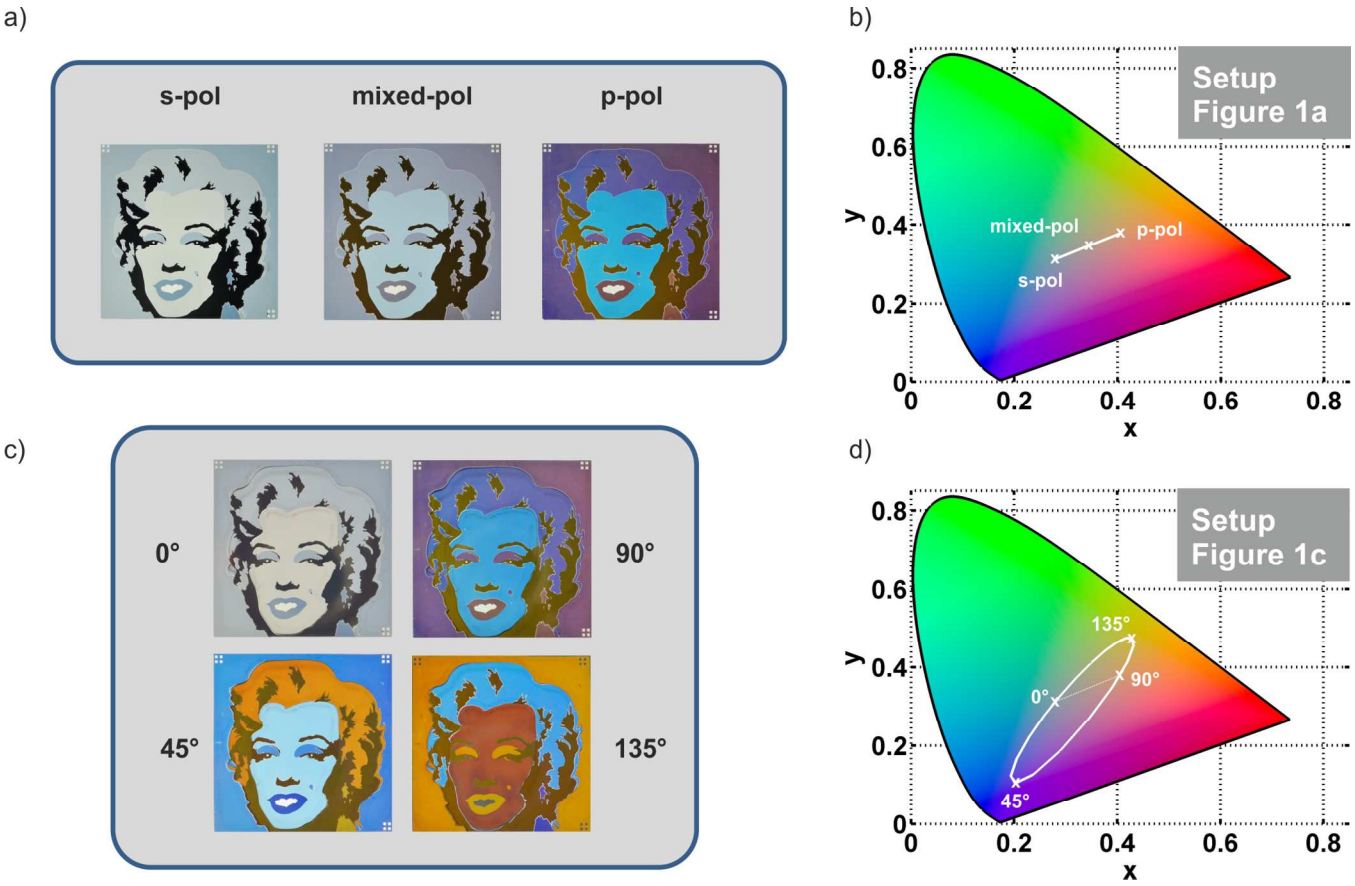

Figure S3. *Color rendering and image formation of Figure 5 with the two different setup of Fig. 1a,c. High contrast colors are induced by the proposed phase shift. Derived from Original Artwork by Andy Warhol © The Andy Warhol Foundation for the Visual Arts, Inc. / 2015, ProLitteris, Zurich.*