Supporting Information

Self-driving dynamic plasmonic colors based on needle steering for simultaneous control of direction and time on metallic nanogroove metasurfaces†

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Supporting Section S1. The cross-polarized reflectance of the metallic nanogroove metasurface at different incident polarization angles

When the polarization angle θ of the incident linearly polarized light is greater than 0° and less than 90° ($0° < \theta < 90°$), the incident electric field has an electric field component in the direction that is perpendicular to the grooves. The amplitude of this electric field component is proportional to cosθ. Then this electric field component has a projection component in the direction that is perpendicular to the incident electric field. The amplitude of this electric field component is proportional to sinθcosθ. Hence, the cross-polarized reflectance at the resonant wavelength is in proportion to the square ($I = \sin^2\theta\cos^2\theta$) of the amplitude of this electric field component. The simulated result is in good agreement with the formula $I = \sin^2\theta\cos^2\theta$, as shown in Fig. S1.

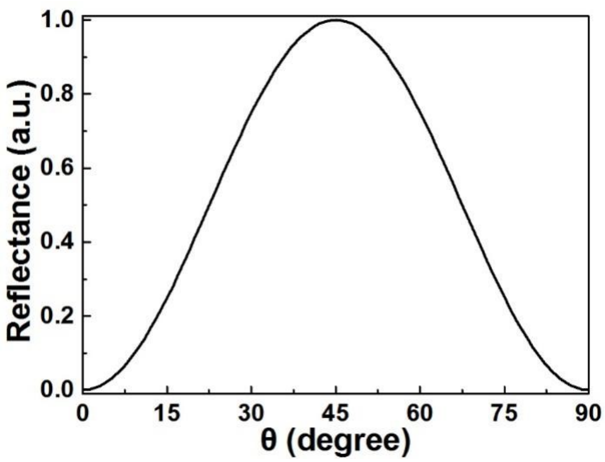

Fig. S1 The cross-polarized reflectance of the metallic nanogroove metasurface (p = 450 nm) at the resonant wavelength (λ = 510 nm) at the incident polarization angles ranging from $\theta = 0°$ to $\theta = 90°$.

Supporting Section S2. Optical property of the metallic nanogroove metasurface

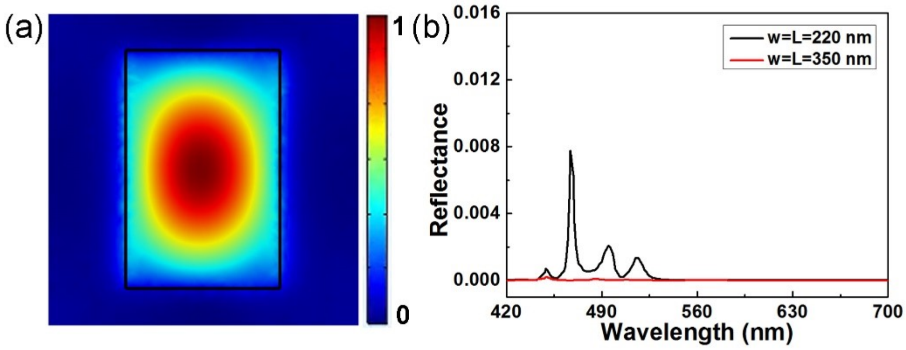

Fig. S2 (a) Top view of the electric field $|E_z|$ distribution of the nanogroove at a wavelength of 477 nm. The linearly polarized light is incident at a very small angle (~1°) on the metallic nanogroove metasurface. (b) Calculated cross-polarized reflection spectra of the nanogroove arrays with equal groove width and groove length, excited by light polarized 45° with respect to the *x*-direction.

Supporting Section S3. The integration of a needle and metal film

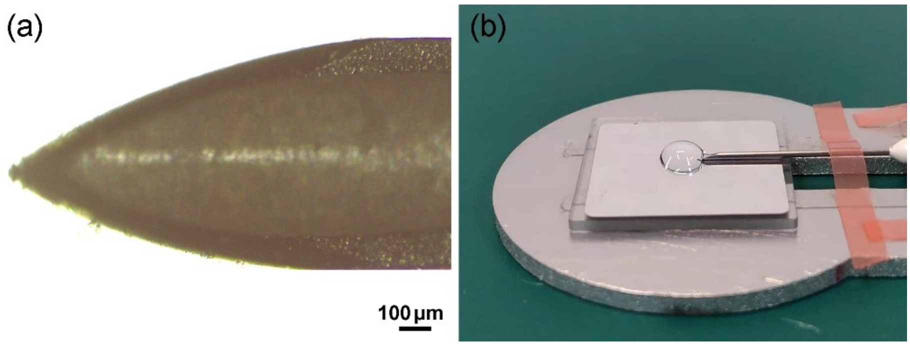

Fig. S3 (a) The optical microscope image of a needle. (b) The optical image of a needle located at the metal film. The droplet on the metal film is closely connected to a needle due to the capillary action.

Supporting Section S4. The dynamic color transition of the patterned color information

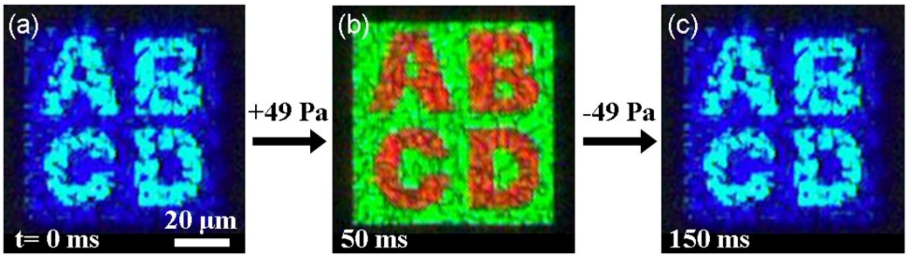

Fig. S4 The optical micrographs of fast reversible color transition of the "ABCD". The colors of the letters and background are changed rapidly and reversibly by controlling gas pressure to drive water. "ABCD" in cyan is displayed against a blue background before the color pattern is covered by water (a). "ABCD" in red is displayed against a green background after the color pattern is covered by water driven by gas pressure (b). The colors of letters and background restore to the initial colors when infused water is removed by decreasing the pressure (c). The images are refocused after the colors change.