Supporting Information

Structural Coloration by Inkjet-Printing of Optical Microcavities and Metasurfaces

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Materials and methods:

Fabrication of the bottom silver mirror

Ceradrop F series was used to print the commercially available silver nanoparticle ink (PVNanoCell Sicrys™ I50T-13) on polyethylene terephthalate (PET) substrates. The substrates were cleaned several times with isopropanol before printing on them. The jettability was optimized for long time stability with low droplet misalignment. All measurements were performed at 1 kHz jetting frequency. After printing square boxes of one cm^2 area, the samples were sintered at 140^oC for one hour.

Fabrication of spacer layers

SU8 (2002 series, MicroChem, USA) was used for the spacer layer because of its high optical transparency throughout the visible range. The solid content (from 10 wt% to 20 wt%) of the SU8 2002 was varied using cyclopentanone (Sigma-Aldrich) as solvent. TritonX100 (Sigma-Aldrich) was used as high boiling point cosolvent in the ink formulations. Inkjet Printer Fujifilm Dimatix (DMP 2800) was used to print the spacer layer utilizing a disposable piezo "inkjet" cartridge (10 picoliter drop volume). The drop spacing was 90 μm.

Fabrication of top thin Au films and nanoislands

For thin Au films, 20 nm gold (0.1 nm/s rate) was thermally evaporated onto the samples. For nanoislands, 5-10 nm Au was evaporated at a slower rate (0.01 nm/s) to form the nanoislands.

Characterization

Surface morphology and pixel thickness were characterized by atomic force microscopy in tapping mode (Veeco Dimension 3100 model).

Optical measurement

Reflectance spectra at normal incidence from single pixels were obtained using a custom-made micro-spectroscopic setup. The pixels were illuminated using a 50W halogen lamp attached to a Nikon microscope and the reflected light was collected from the camera port with a light guide connected to a spectrograph (Andor Shamrock 303i, with a Newton CCD detector). Extinction spectra were measured using a UV/VIS/NIR Spectrometer (Lamba900, Perkin Elmer Instruments).

Finite-Difference Time-Domain (FDTD) Simulations

FDTD Solution (Lumerical, version 8.19.1416) was used for the optical simulations. The simulation size was 200 nm on x and y, and varying length (600-1000 nm) on z direction. Anti-symmetric, symmetric and perfectly matched layers (PML) boundary conditions were respectively used for x, y and z to establish a periodic structure in the xy-plane.

Supporting Figures

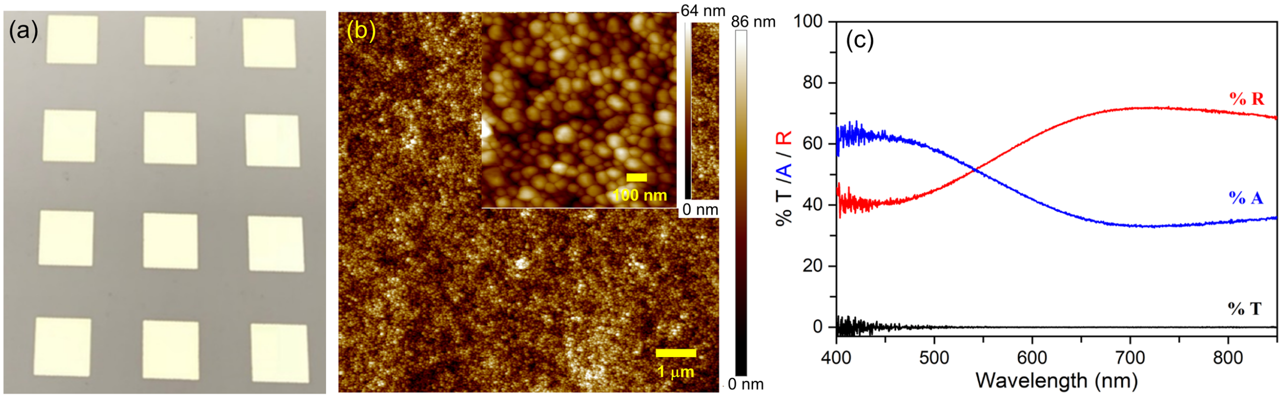

Figure S1: (a) Photograph, (b) atomic force microscopy image (higher resolution in the inset) and (c) optical spectra of the inkjet printed silver mirror on PET substrate (T=transmission, A=absorption, R=reflection).

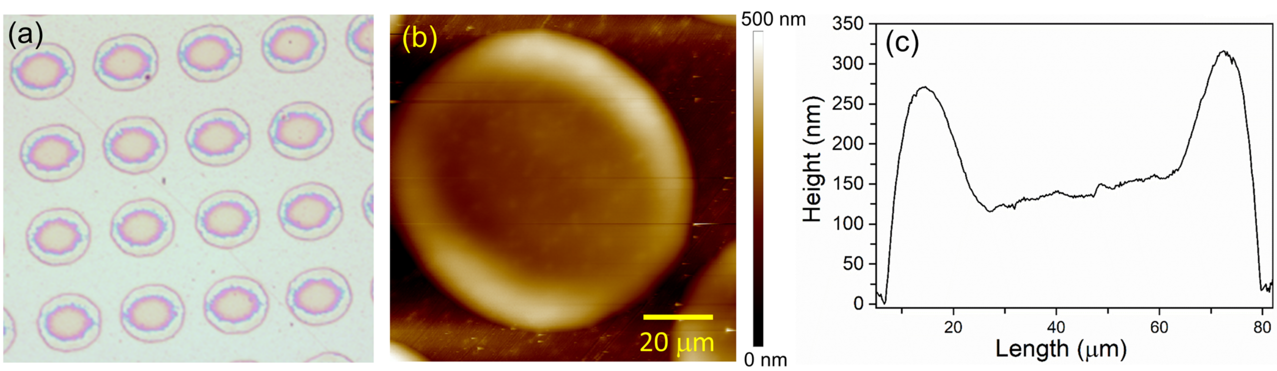

Figure S2: (a) Microscopy image, (b) atomic force microscopy image and (c) height profile of pixels printed with modified SU8 ink on thermally evaporated silver mirror.

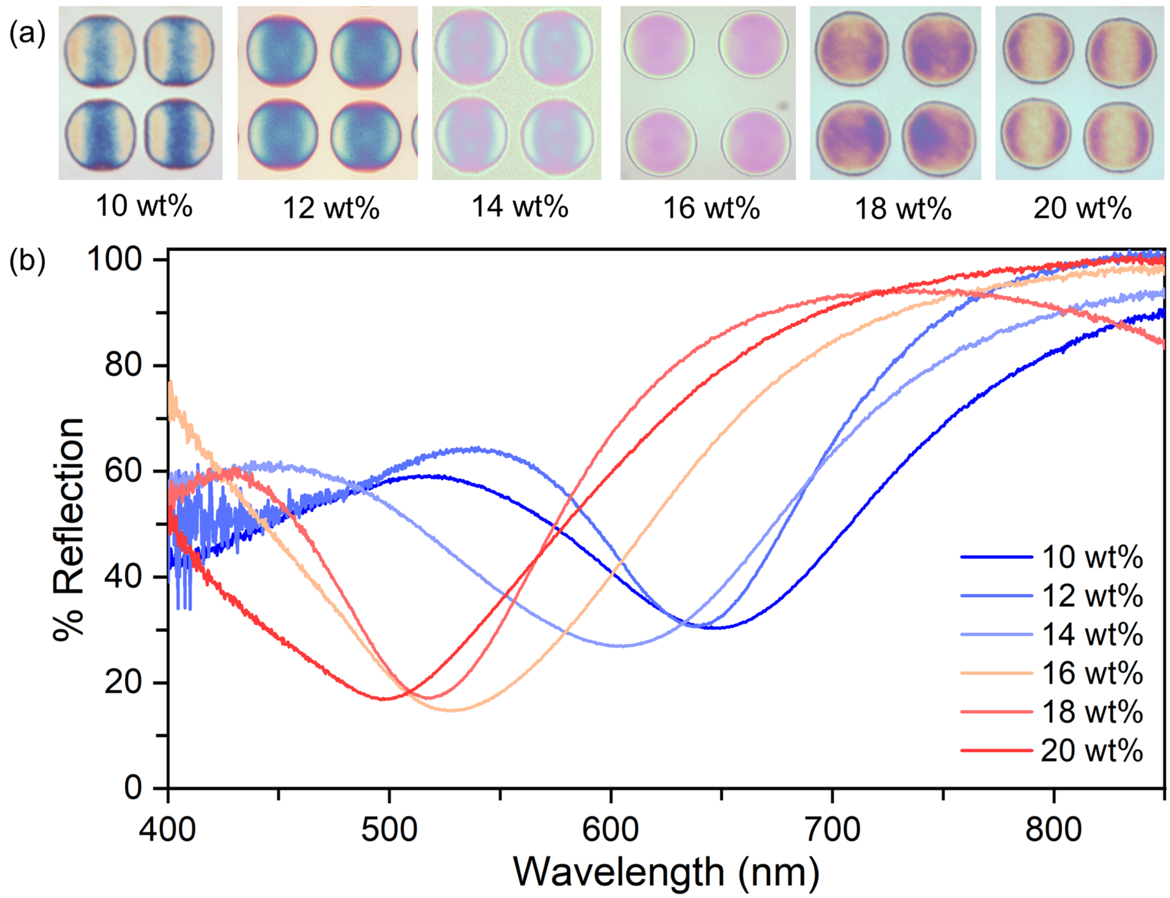

Figure S3: (a) Optical microscopy images of pixels of increasing spacer layer thicknesses (ink used with varying solid content from 10 to 20 wt %, left to right), with 20 nm Au evaporated on top as semitransparent layer to complete the optical microcavity. (b) Reflection spectra from the pixels.

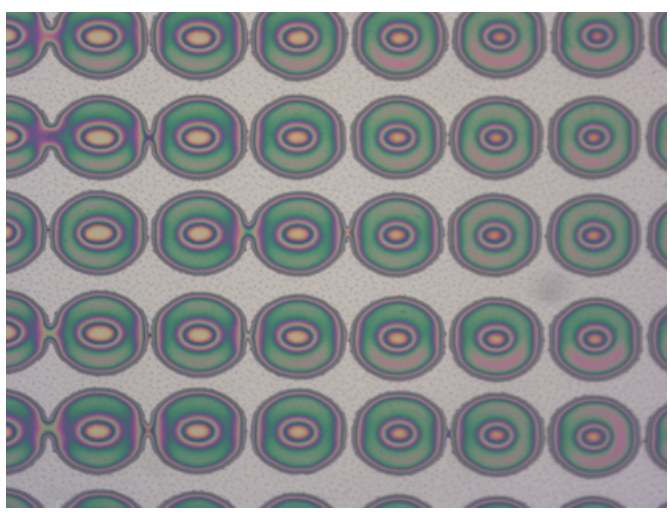

Figure S4: (a) Optical microscopy image of an array of pixels made by double printing of two drops (18 wt% solid content) on top of each other on the silver mirror, followed by coating by a 20 nm Au film.

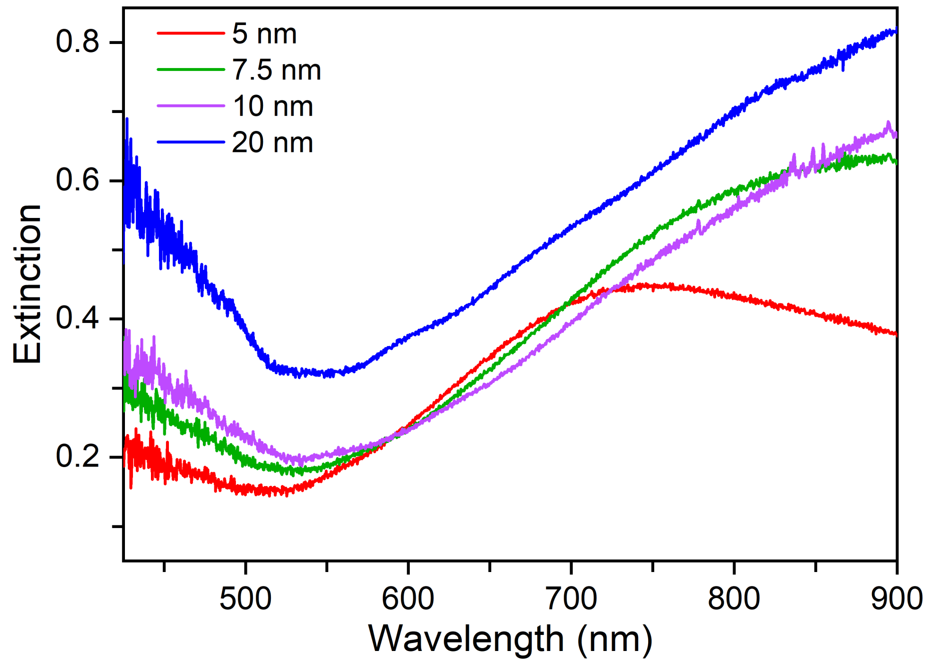

Figure S5: Extinction spectra of samples made by slow evaporation of gold at different thicknesses onto SU8-coated PET substrates.

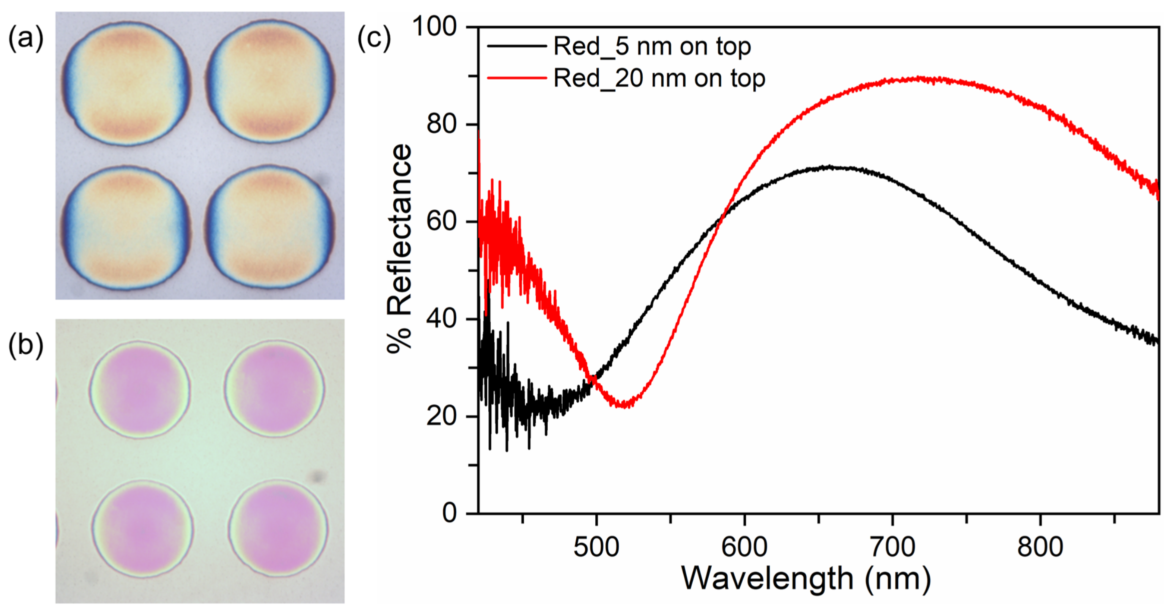

Figure S6: Optical microscopy images of pixels with spacer layer thickness 123 nm, coated by either (a) 5 nm or (b) 20 nm gold top layer. (c) Reflection spectra of the corresponding pixels.

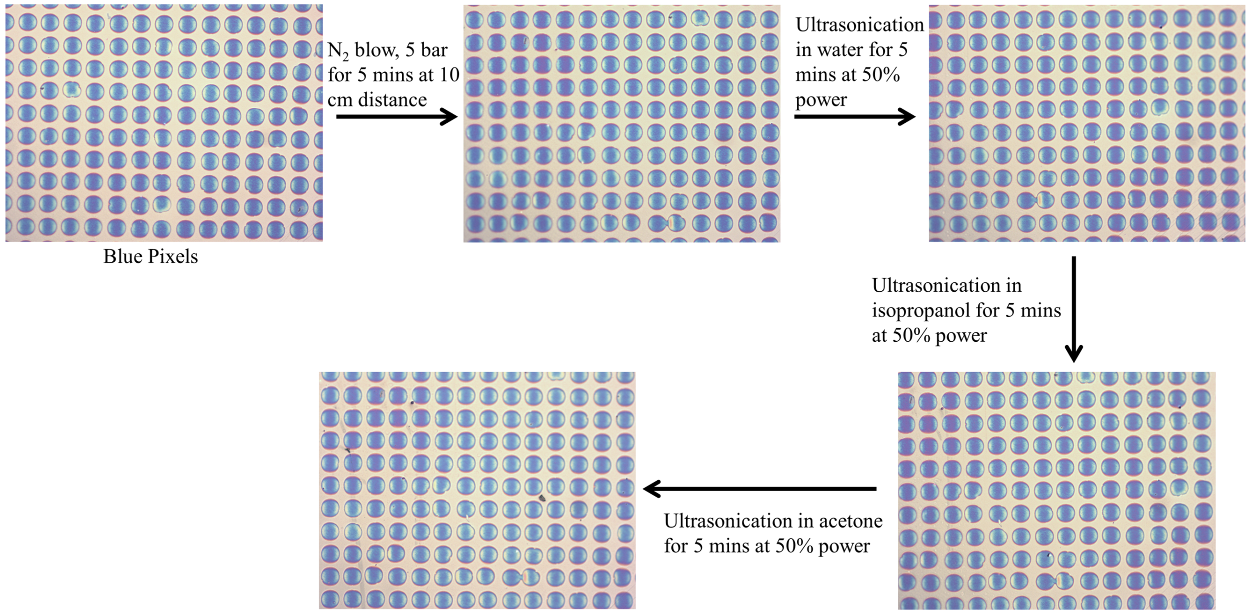

Figure S7: Optical microscopy images of blue pixels under different stability tests (both chemical and mechanical stability).