Supplementary Information for

Optically Anisotropic, Electrically Tunable Microlens Arrays Formed via Single-Step Photopolymerization-Induced Phase Separation in Polymer/Liquid-Crystal Composite Materials

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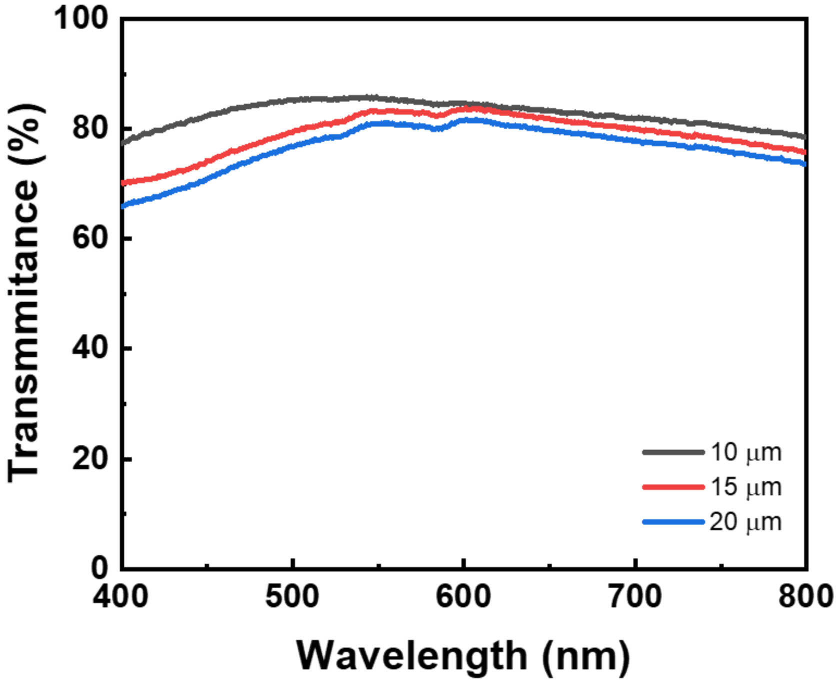

Figure S1. The transmittance of the fabricated microlens arrays with the cell gaps of 10 μm, 20 μm and 30 μm.

To capture the EIA, the microlens array is placed in front of a camera, as shown in Figure S2. Every microlens images the object separately, acting as a micro-camera. Such a setup for photography is known as the "Lippmann sensor"[1]. Compared with traditional two-dimensional cameras, this "Lippmann sensor" not only records the intensity information of the light from the object but also the angle information. Figure S2a shows the schematic of the acquisition of EIA. Figure S2b shows the relative positions of two objects along the optical axis. Figure S2c shows the captured EIA by the CCD. We further designed and fabricated a photomask as the display panel for 3D display by binarizing the captured image of EIA, as shown in Figure S2d.

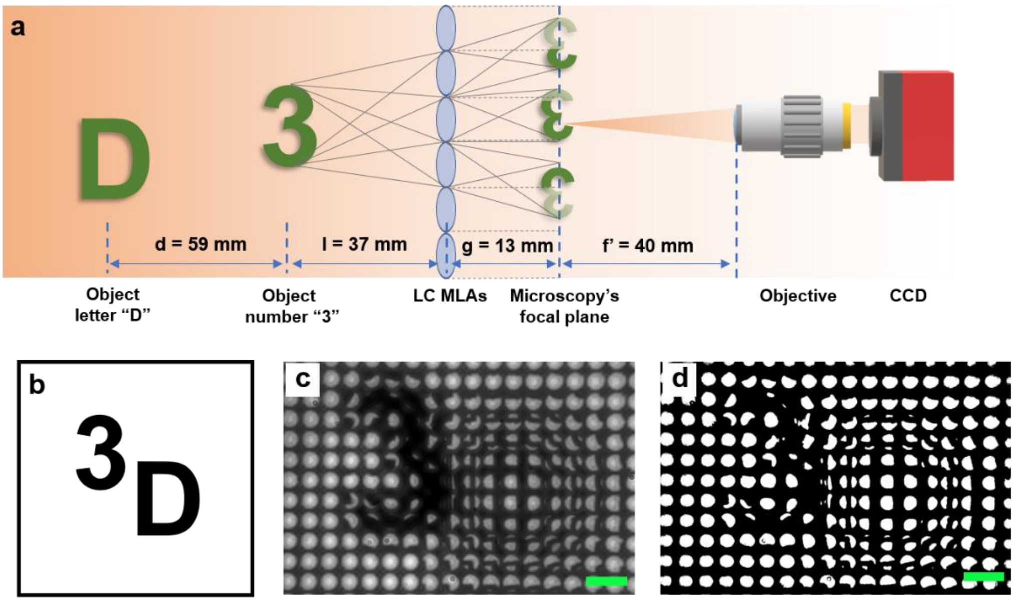

Figure S2. Schematic of the acquisition of EIA. (a) A collimated white light source is used to illuminate two objects "3" and "D". A 10× objective and a CCD are integrated to serve as the microscopy. The designed distances between each element are also labeled; (b) The original objects; (c) The captured image of EIA; (d) The binarized image of the captured EIA image. Scale bar: 500 μm.

Reference

1 Lippmann, M. G. Épreuves réversibles donnant la sensation du relief. *Journal de Physique Théorique et Appliquée* **7**, 821-825 (1908).

Description for supplementary videos

supplementary video S1: The phase separation process is shown in this video. A cell filled with a mixture of LC and prepolymer is exposed to a normally incident, collimated UV laser beam. By using a suitable photomask during UV exposure, an additional intensity gradient is created in the x-y plane of the cell. The NOA65 monomers in the high-intensity regions near the UV beam undergo polymerization first, while those in the low-intensity regions diffuse towards the high-intensity regions to maintain their relative concentration, causing the LCs to be expelled from the polymerization regions inside the cell. With precise exposure conditions, extended UV exposure completely consumes all the NOA65 monomers and drives the LCs out of the polymerized volume. At the same time, the LC molecules align with the alignment layer. Finally, the bi-layer structure is formed.

supplementary video S2: In this video, the sharp focal points were captured by a CCD. When we rotated the polarizer 180 degrees, the focal points became dim and finally bright and sharp again.

supplementary video S3: In this video, when we applied the voltage on the sample, the focal points were getting dim gradually and finally disappeared.

supplementary video S4： In this video, we applied 9 volts on the sample and rotated the polarizer. The image kept being blurry all the time, which indicates that the LC molecules were almost totally realigned along the electric field.

supplementary video S5： In this video, we moved the position of the LC microlens arrays from the focal plane to the image plane. As we can see, the image became larger when we moved the sample to the light source.

supplementary video S6： In this video, we altered the polarization of the incident light by rotating the polarizer. In the beginning, the polarization of the incident light was parallel to the LC alignment direction. As we rotated the polarizer 180 degrees, the images became blurry and finally clear again.

supplementary video S7: In this video, the clear images of the object, a capital letter “F”, were captured by a CCD. When we applied an AC signal on the LC microlens arrays, the images became blurry gradually. As we increased the voltage, the images were totally unrecognized.

supplementary video S8: In this video, the reconstructed objects “3” and “D” were captured by the microscopy system with continuously changed positions along the optical axis. As we can see, the object “3” became blurry while “D” became clear gradually.