
Artificial Eye

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Current imaging systems require heavy and expensive compound lenses to project an object onto a flat focal plane array. In contrast, biological systems (e.g., the human eye), employ a hemispherical image plane, thus considerably simplifying the imaging optics. In order to create a compact imaging system that mimics the architecture of the human eye, we demonstrate a 3-D stamping technique to pattern organic photodetector arrays onto hemispherical plastic substrates (Figure a).

Si masters with line-patterns are generated using conventional photolithography. PDMS prepolymer mixed with a curing agent are poured onto the Si master and cured at 100°C. The substrate is heated and deformed into a hemispherical shape in a vacuum mold. A 100Å-thick and a 50Å-thick Au layers are deposited onto the stamp and the deformed substrate, respectively. A similarly shaped, second metal mold holds the PDMS stamp in a hemispherical shape by vacuum. When the two 3-D surfaces are brought into contact, the vacuum is released from the mold holding the PDMS stamp, allowing the PDMS to conformal contact with the substrate, transferring the metal to the substrate. The continuous metal layer on substrate is removed in an Ar plasma, leaving Au anodes patterned on the curved plastic substrate (Figure b). To complete the organic photodetector array on the pre-shaped substrate, we next deposit, by vacuum thermal evaporation, organic photodetector materials onto the entire substrate surface. The 3-D stamping technique is applied once more to pattern the top Ag cathode rows orthogonal to Au anode columns.

By this method, we fabricated a curved focal plane array consisting of $(40\mu\text{m})^2$ organic photodetectors (Figure c) with dark current density $5.3\pm 0.2\ \mu\text{A}/\text{cm}^2$ at -1V bias. A peak external quantum efficiency reaches $12.6\pm 0.3\%$ at a wavelength of 640nm. The photodetector impulse response is $20\pm 2\text{ns}$, making the array suitable for video recording applications. This project is being supported by the Defense Advanced Research Projects Agency under award number FA9550-06-1-0254, and by Universal Display Corporation.

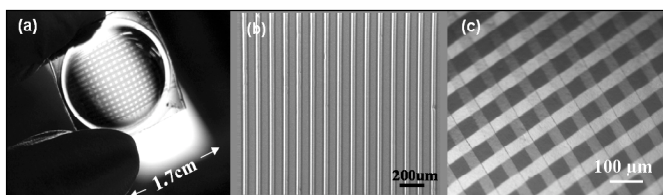


Figure (a) A 1cm-radius hemispherical focal plane array consisting of $(500\mu\text{m})^2$ organic photodetectors, (b) $40\mu\text{m}$ wide Au anode patterns on hemispherical plastic substrate, (c) $(40\mu\text{m})^2$ organic photodetector arrays fabricated by 3-D stamping technique.