

# Novel processing methods for patterning micro-structured polymers

M. Wu<sup>1</sup>, A. Kuhne<sup>2</sup>, B. Guilhabert<sup>1</sup>, E. Gu<sup>1</sup>, A.R. Mackintosh<sup>2</sup>,  
R.A. Pethrick<sup>2</sup>, M.D. Dawson<sup>1</sup>

1) Institute of Photonics, SUPA, Wolfson Centre, University of Strathclyde, 106 Rottenrow, Glasgow, G4 0NW, Scotland

2) Pure and Applied Chemistry Department, University of Strathclyde, 295 Cathedral street, Glasgow, G1 1XL, Scotland

## Abstract

A study of microstructure-patterning in photo-curable polymers utilizing some novel processing methods is shown. The key work is on polymeric structures formed by (1) electric fields and (2) aperture masks. The electrically induced structure formation shows much promise in patterning different kinds of polymers, as has been reported in ref 1 and 2. And the "bottom up" ultraviolet curing through aperture masks is a simple patterning technique used in shaping both ultraviolet (UV) transparent polymers (HTP) and blend polymers (light-emitting polymer and HTP). The fabrication of polymer micro-lenses by using photoresist reflow and RIE etching is presented as well.

### Photo-curable polymers

Photo-curable polymer used in the electrically induced formation. Fig 1(a) is the molecular unit of the polymer, Fig 1(b) is the absorption spectrum, Fig 1(c) is the transmission spectrum.

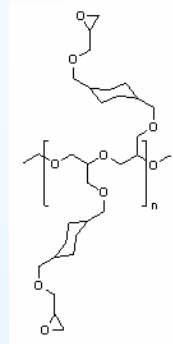


Fig 1(a)

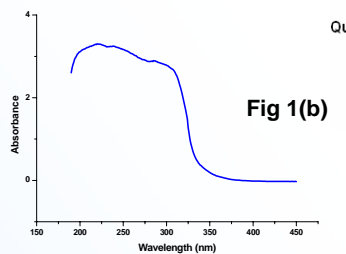


Fig 1(b)

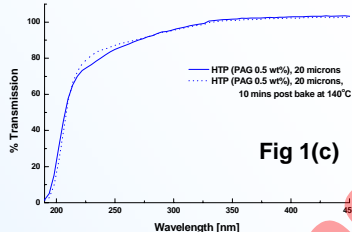


Fig 1(c)

### Electrically-induced experiment set-up

Electrically induced formation experiment set-up (Fig 2(a)) and a schematic picture of the upper electrode (Fig 2(b))

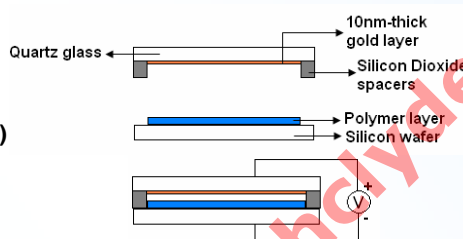


Fig 2(a)

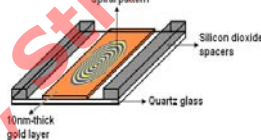


Fig 2(b)

### Bottom-up UV Curing and thermal reflow technique

Another patterning method is "bottom-up" UV curing through aperture mask. Fig 3 is the lay-out of the experiment

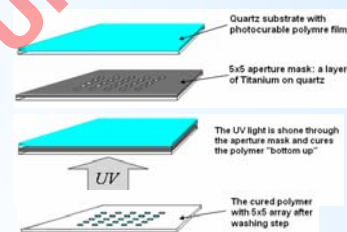


Fig 3

The thermal reflow process is applied in micro-lens fabrication. Fig 4 shows the process

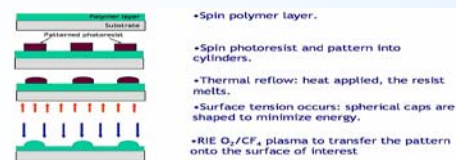


Fig 4

### Electrically induced formation

Fig 5(a) shows the pillars formed by the electric field strength. Fig 5(b) shows the replication of the pattern on the upper electrodes.

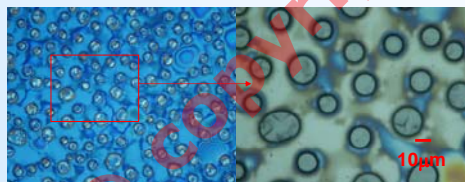


Fig 5(a)

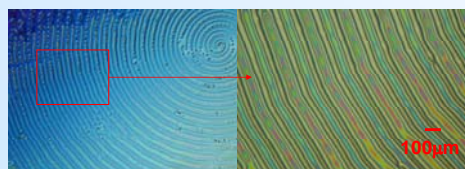


Fig 5(b)

### "Bottom up" UV curing through aperture

Fig 6 shows the ultraviolet transparent polymer spots array formed by aperture curing. The UV wavelength is 368nm / 5mW/cm<sup>2</sup>, and the cure time is 4min.

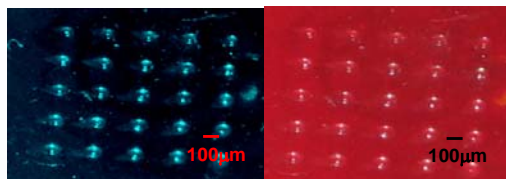


Fig 6

Light-emitting polymer blended with the ultraviolet transparent polymer can be shaped through the aperture as well. Fig 7 shows different blend polymer patterned by the aperture curing under the same UV wavelength and the cure time is 2s.

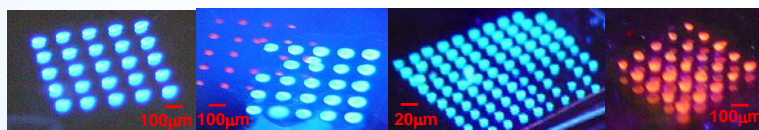


Fig 7

Polymeric micro-lens, micro-rings and cylindrical lens have been fabricated by thermal reflow and RIE etching. (Fig 8)

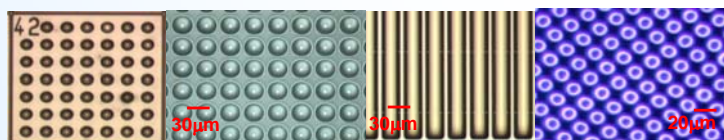


Fig 8

### References:

1. E. Schaffer. *Electrically induced structure formation and pattern transfer*. Nature (London), 403, 874 (2000)
2. M.D.Dickey. *Photocurable pillar arrays formed via electrohydrodynamic instabilities*. Chem. Mater., 18, 2043 (2005).