

Enhancement of light emitting properties by simultaneously patterning and controlling the molecular alignment in polyfluorene thin films

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The PFO nanogratings were fabricated by the soft NIL process, whose fabrication process was shown in Fig. sp1. The soft-NIL process was schematically shown in Fig. sp1(a), during which the template used here was PDMS soft template as the consideration of its fabrication cost. The PDMS stamp was shown in Fig. sp1(b), whose area was about 64 mm². The height of the stamp was about 100 nm with the 300nm line-width and the duty cycle around 0.5, as shown in Fig. sp1(c)-(d).

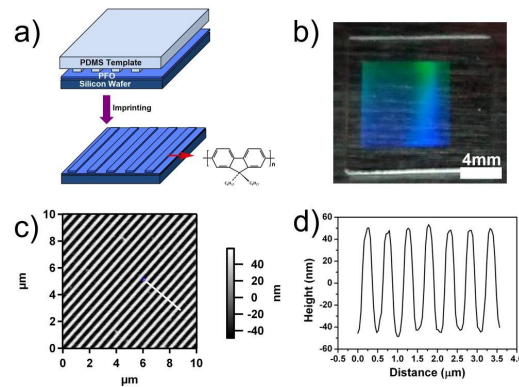


Fig. sp1. The soft-NIL nanoimprint process and the template morphology. (a) the soft-NIL process to fabricate the PFO nanogratings. (b) the optical image of the PDMS soft template. (c) The AFM image of the PDMS template. (d) the surface profile of PDMS soft template marked as the white line in fig. 1(c).

During this soft NIL process, the initial layer thickness of PFO was the only variable, and all the controllable imprinting conditions kept constant. The cross sections of these embossed PFO were characterized by SEM as shown in Fig. sp2. In these cross section images, the variation of the residual and protrusion layer thickness could be easily identified. As the stamp used in this work was the soft stamp PDMS, the PFO layer could not be cut off thoroughly during the NIL process. Hence, the minimum thickness of residual layer could not be avoided under the soft NIL process. In the Fig. sp2, the initial layer thickness of spin-coated PFO thickened from (a) 25 nm to (f) 90 nm. From (a) to (c), the residual layer thickness kept at its thinnest less than 10 nm when the initial layer

thickness varying from 25 nm to 50 nm, while the protrusion layer thickness thickened with the initial layer thickness. From (d) to (f), the protrusion layer thickness kept constant at full-filled state around 100 nm, while the residual layer thickness thickened with the initial thickness.

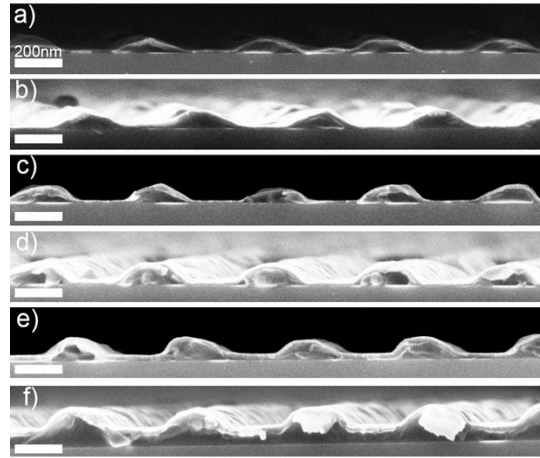


Fig. sp2. SEM morphologies of the cross section of the embossed PFO nanogratings. The embossed PFO nanogratings with the initial layer thickness (a) 25 nm, (b) 30 nm, (c) 50 nm, (d) 60 nm, (e) 75nm and (f) 90 nm.

The PFO was dissolved in the toluene, and the concentrations were varying from 10 mg/ml to 20 mg/ml, and the film thickness was determined by the solution concentration and the spin-coating speed. Then the PDMS mold was pressed against the films under pressure (60 bar) at 180 °C for 5 min to make sure that nano-convexes on the soft mold could be fully immersed into the PFO layer, then cooled down to 135 °C and held for 10 min, slowly cooled down to the room temperature (30 °C). Before releasing the pressure, the stacks were evacuated to solidify the PFO nanogratings. As the AFM image shown in Fig. sp3, the 300 nm line-width PFO nanogratings with different initial layer thickness were reproduced on the silicon wafer. By carefully tuning the initial PFO layer thickness, the different filling quantities in the same PDMS stamp could be easily realized during

the soft NIL process. Hence, a serial of different residual and protrusion layer thickness could be achieved after this NIL process. As the nano-trenches on the PDMS template were about 100nm deep, the protrusions on the PFO nanograting could not exceed 100nm height, shown in Fig. sp3(b)-(c).

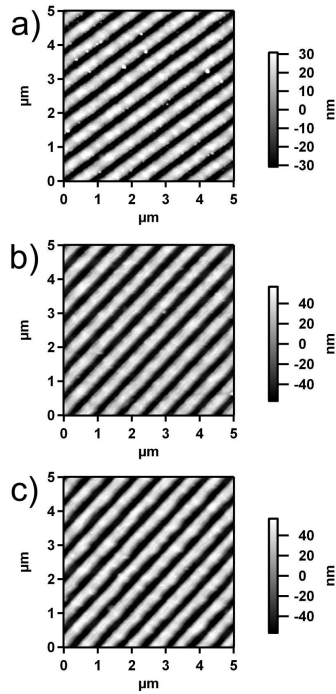


Fig. sp3. The AFM images of the PFO nanogratings with the initial film thickness about 30nm (a), 50nm (b) and 90nm (c).