Electronic Supplementary Material (ESI) for Polymer Chemistry.

Supplementary Information for:

Hierarchical patterns with sub-20 nm pattern fidelity via block copolymer self-assembly and soft nanotransfer printing

Helen Tran[1,†], Harrison M. Bergman[1, §], Kaia Parenti[1], Arend M. van der Zande[2, ǁ], Cory R. Dean[3], Luis M. Campos[1]*

[1]Department of Chemistry, Columbia University, New York, NY, 10027. [2]Department of Mechanical Engineering, Columbia University, New York, NY, 10027. [3]Department of Physics, Columbia University, New York, NY, 10027.

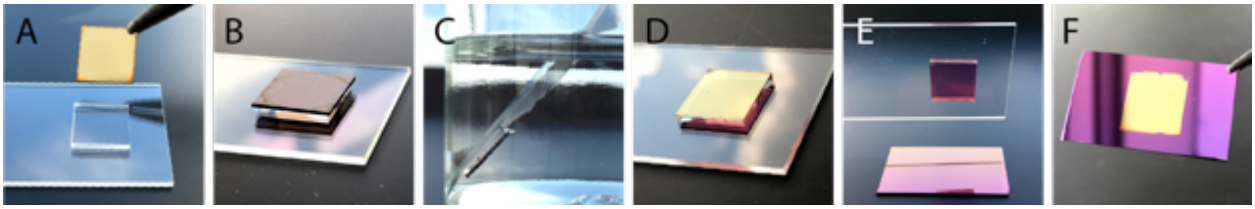

Figure S1. Optical images of soft pattern-transfer printing process. (A) A film of P3HT is spin coated on 280 nm SiO_2/silicon and show next to a piece of PDMS stamp adhered to a glass slide. Notably, the PDMS was cured in an oven for 2 days to ensure full crosslinking then subsequently washed with toluene to ensure removal of unreacted materials. (B) The P3HT film is placed in direct contact with the PDMS and (C) soaked in 1M KOH. (D) The P3HT film is transferred to the PDMS after SiO_2 etches and the silicon substrate detaches. (E) The P3HT film on PDMS is

placed in direct contact with a new piece of 280 nm SiO_2/silicon and (F) the PDMS stamp was removed to reveal the final transferred P3HT film on 280 nm SiO_2/silicon.

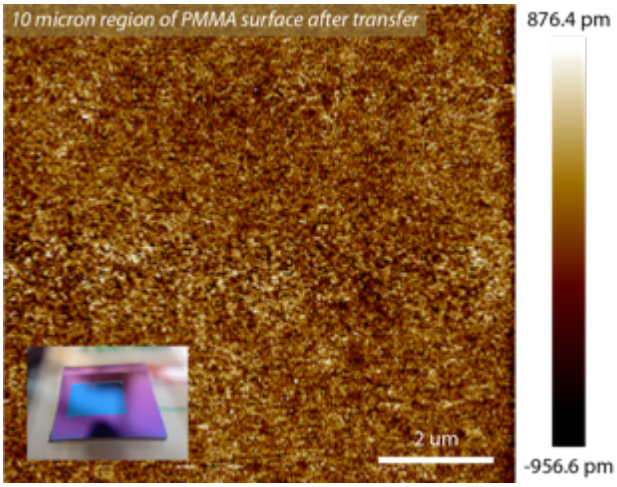

Figure S2. AFM of PMMA film after transfer. The surface of the PMMA after transfer over a 10 μm region shows noise of less than 1000 pm (or 1 nm). The inset shows a photograph of the transferred PMMA film (blue) on a piece of silicon with 280 nm SiO_2.

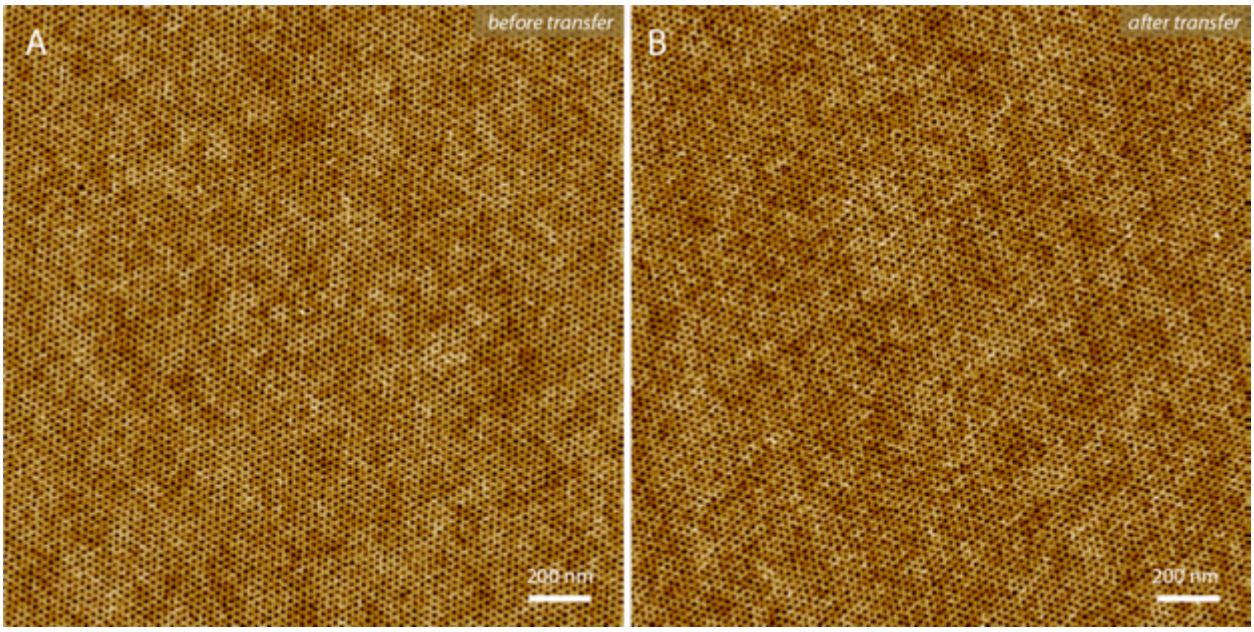

Figure S3. AFM images of thin films of PS-*hv*-PEO over 2 μm. (A) The nanopatterns imaged before transfer are retained (B) after soft pattern-transfer printing.

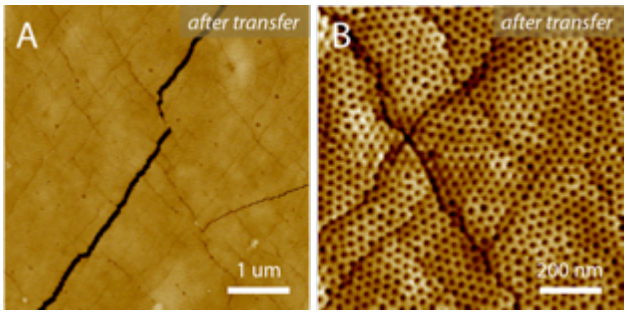

Figure S4. AFM images of thin films of PS-*hv*-PEO prepared with too much pressure. (A) The nanoscale features deriving from the diblock copolymer are observed in addition to cracks. (B) Larger cracks are seen is a larger scan (black lines).

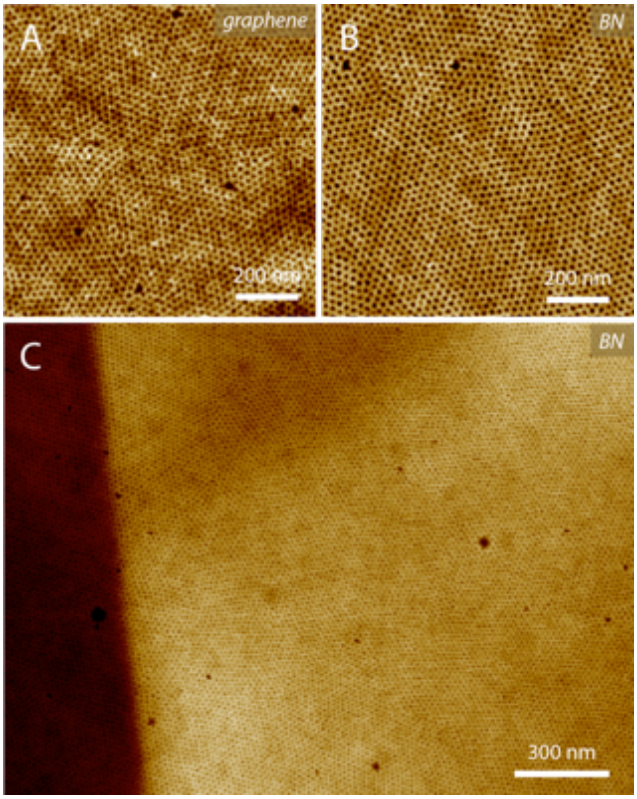

Figure S5. Solvent annealing of PS-*hv*-PEO on 2D materials : (A) graphene and (B,C) boron nitride. (C) The edge of a BN flake is observed as the brighter region on the right, where the darker region is PS-hv-PEO on SiO2.

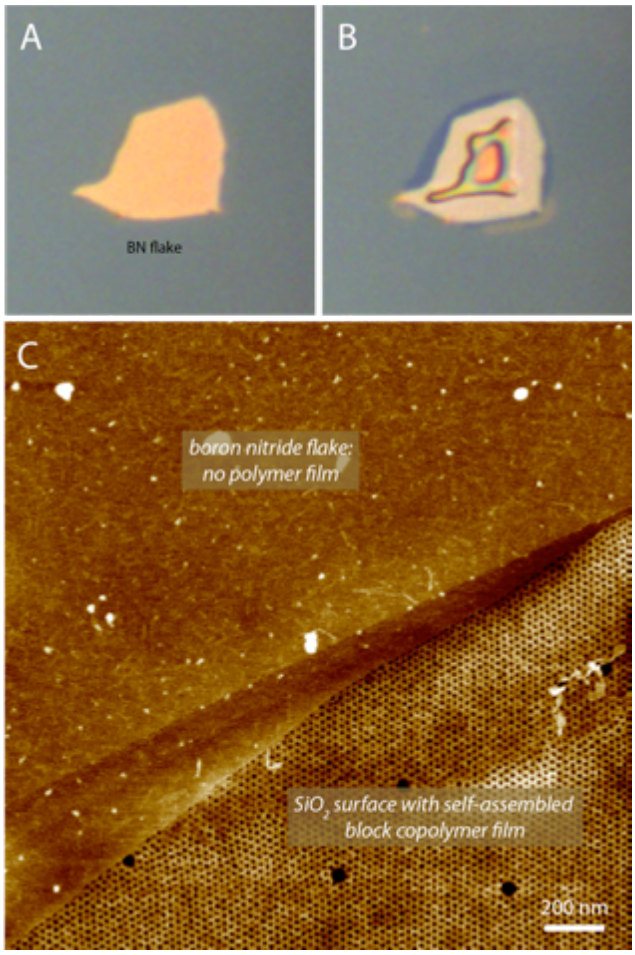

Figure S6. Solvent annealing of PS-*hv*-PEO on exfoliated boron nitride flake. (A) The BN flake with a thin film of PS-*hv*-PEO spin coated on top, showing uniform film quality. (B) After solvent vapor annealing, the thin film detaches at the edges and dewets, resulting in no thin film on the edges of the flake, (C) as observed by AFM. A thicker region of the polymer gathers towards the center of the flake.

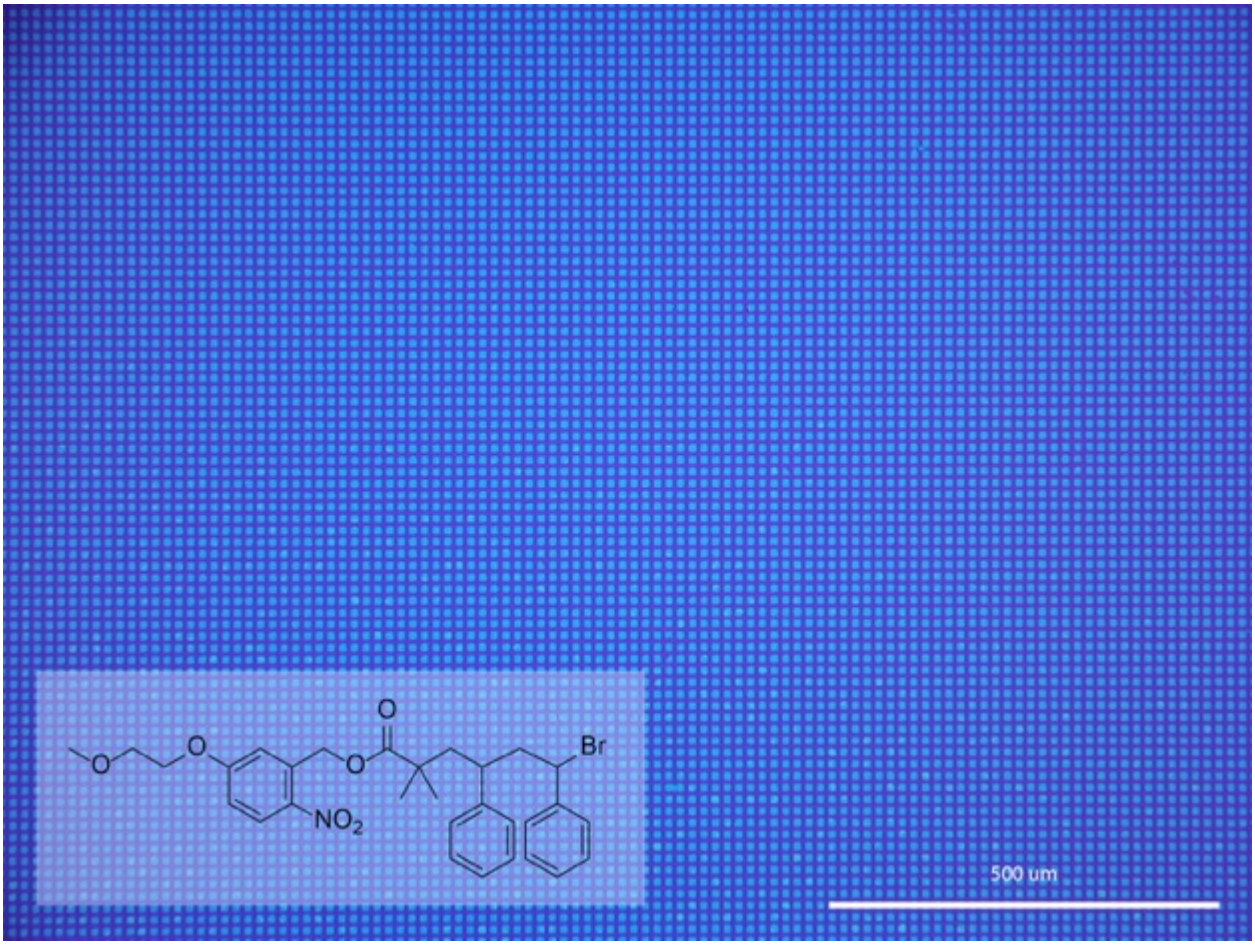

Figure S7. Optical image of PS-*hv*-PEO thin films printed with micropatterned PDMS stamp. An array of squares is printed over a large area.

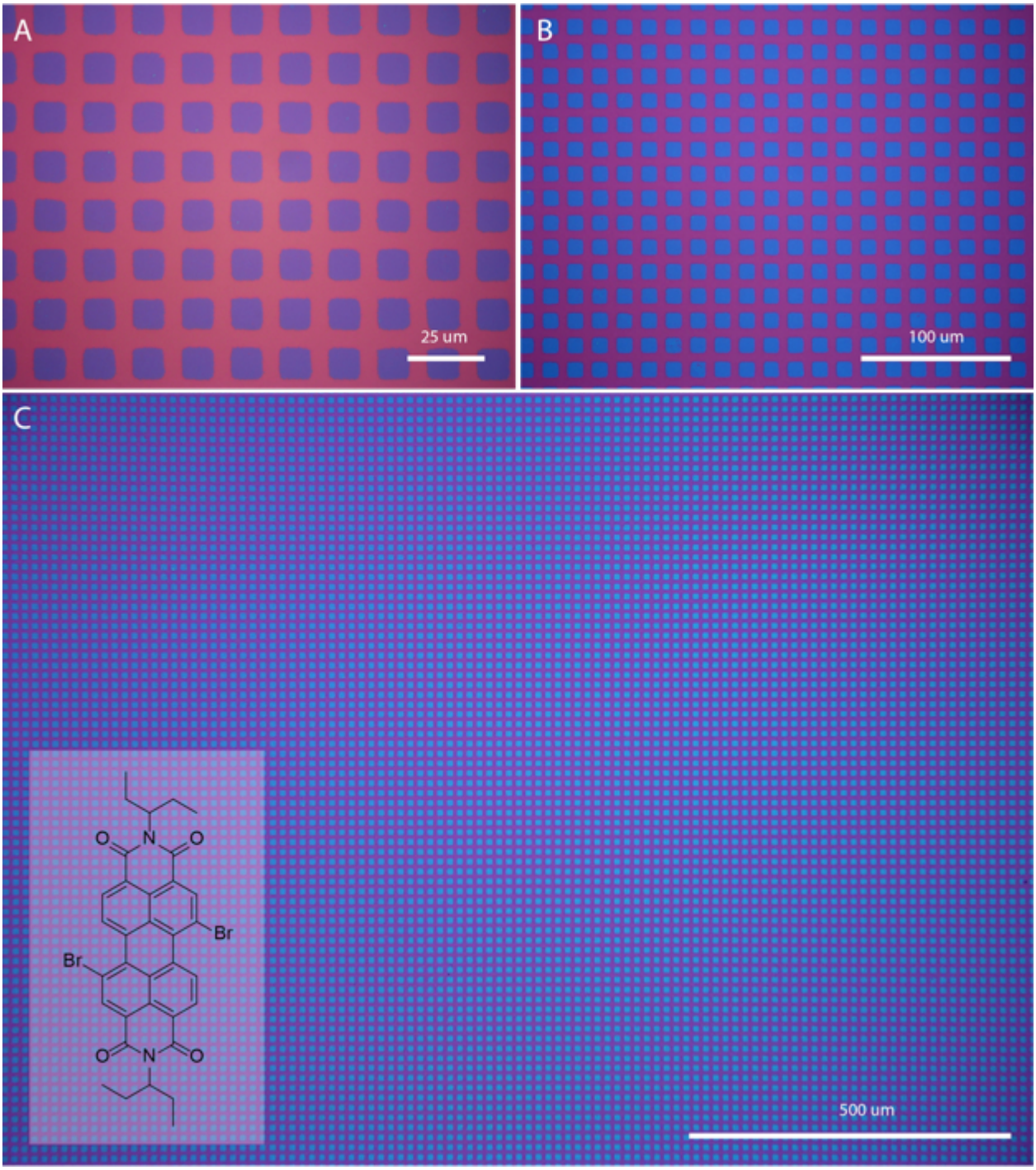

Figure S8. Optical images of 1,7 dibromo-perylene diimide with C5 chains thin films printed with micropatterned PDMS stamp. (A-C) An array of squares is printed over a large area.

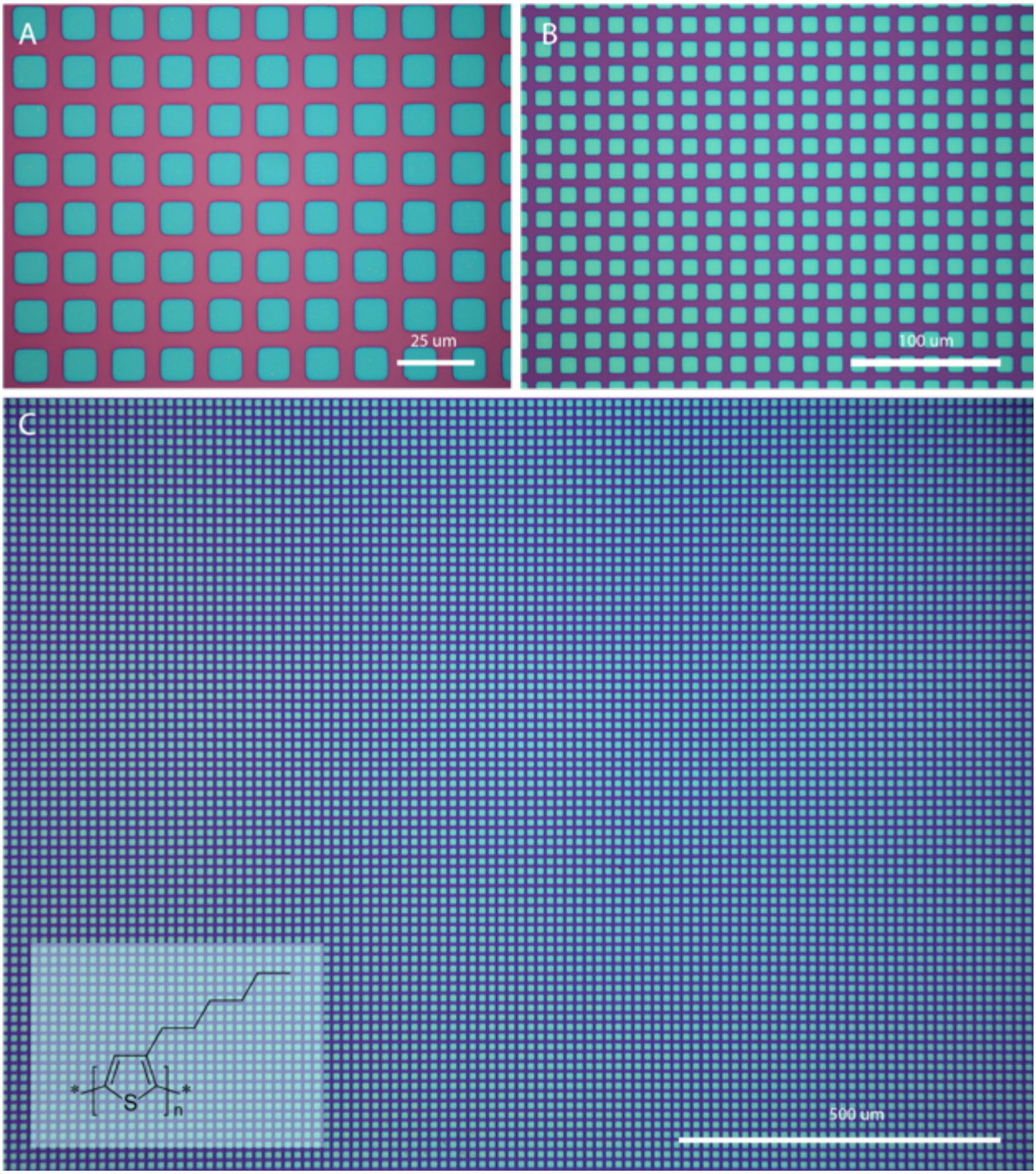

Figure S9. Optical images of regioregular P3HT thin films printed with micropatterned PDMS stamp. (A-C) An array of squares is printed over a large area.

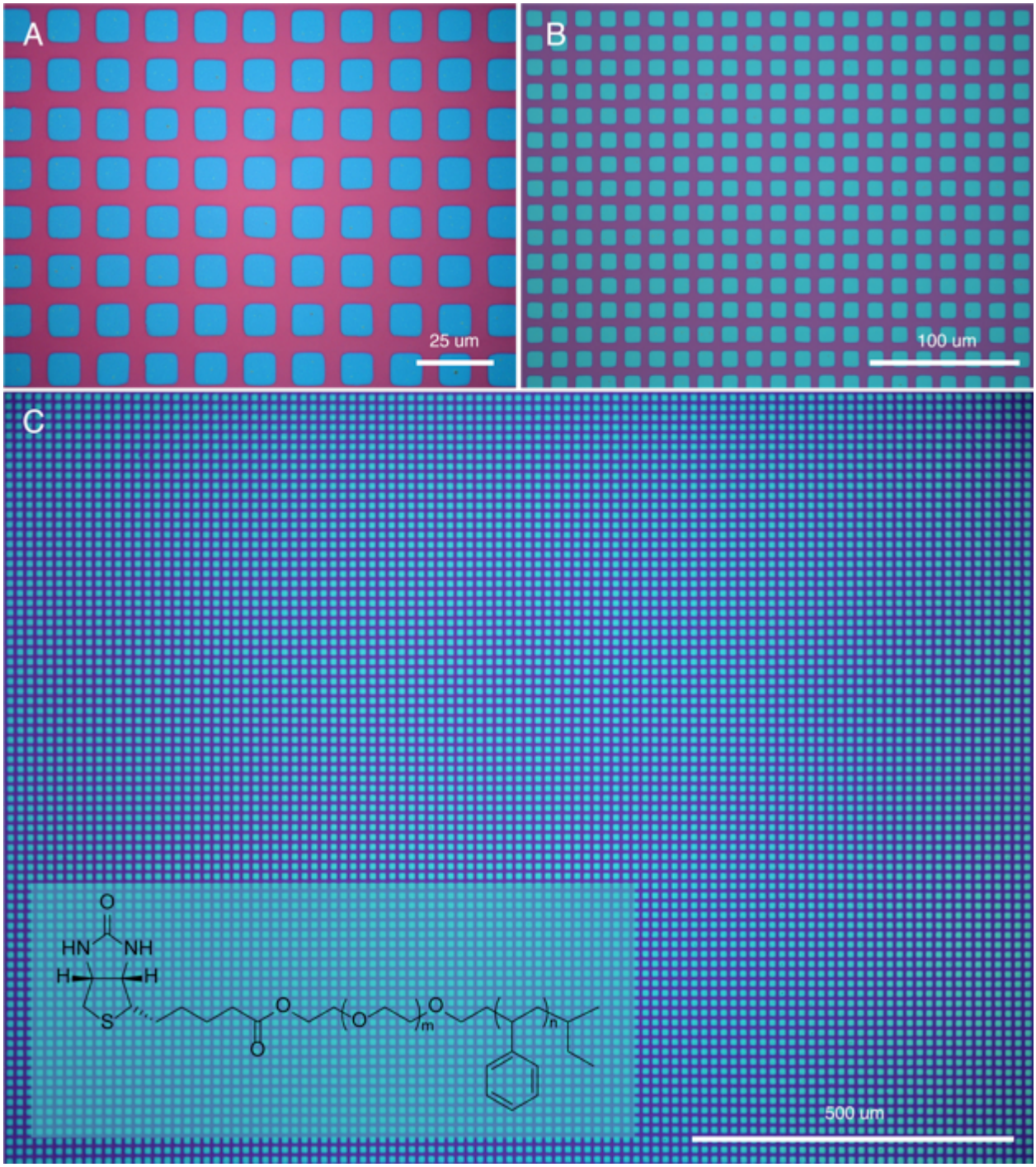

Figure S10. Optical images of PS-*b*-PEO-biotin thin films printed with micropatterned PDMS stamp. (A-C) An array of squares is printed over a large area.

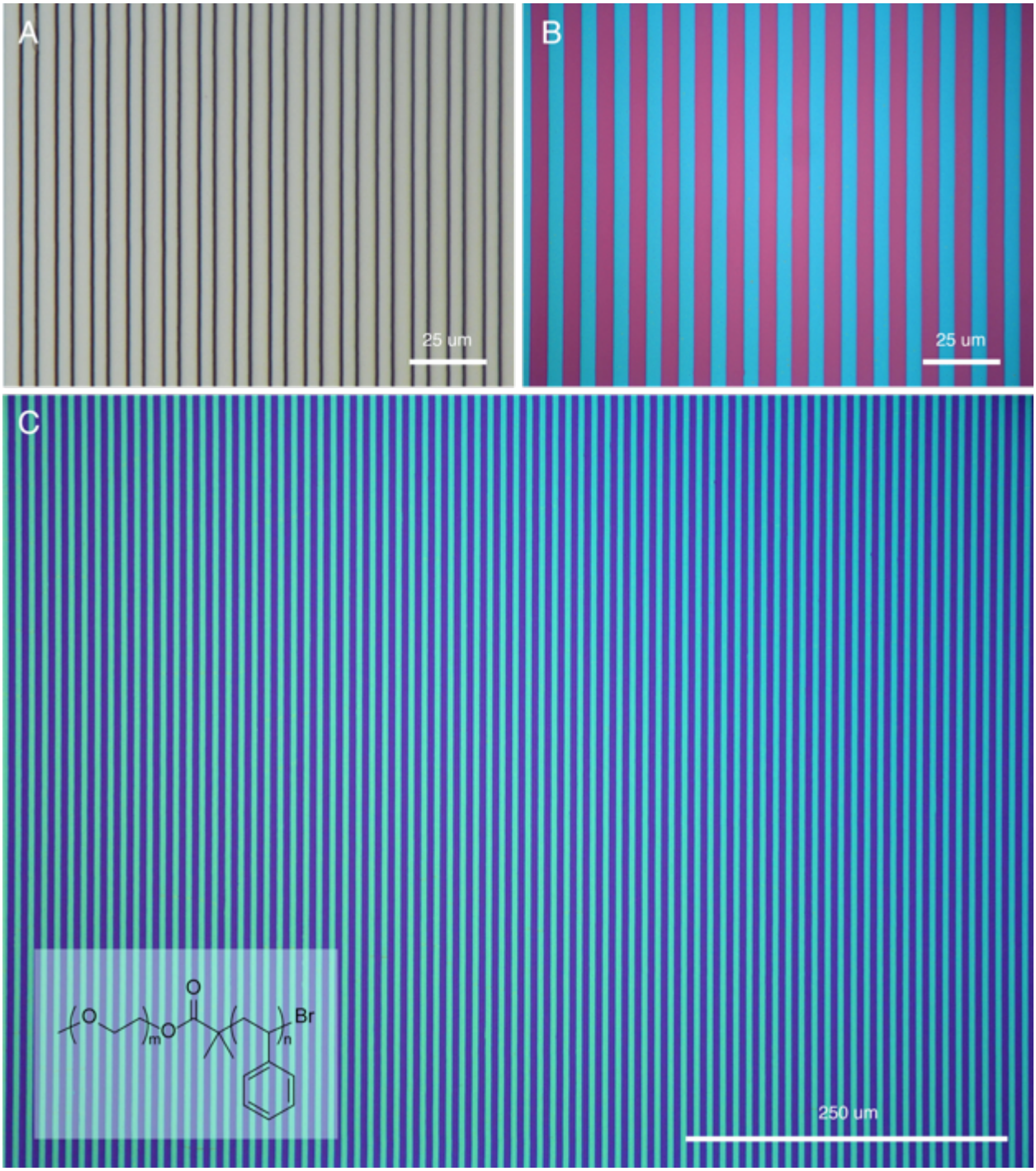

Figure S11. Optical images of PS-*b*-PEO thin films printed with (A) micropatterned PDMS stamp with line pattern. (B-C) An array of lines is printed over a large area.

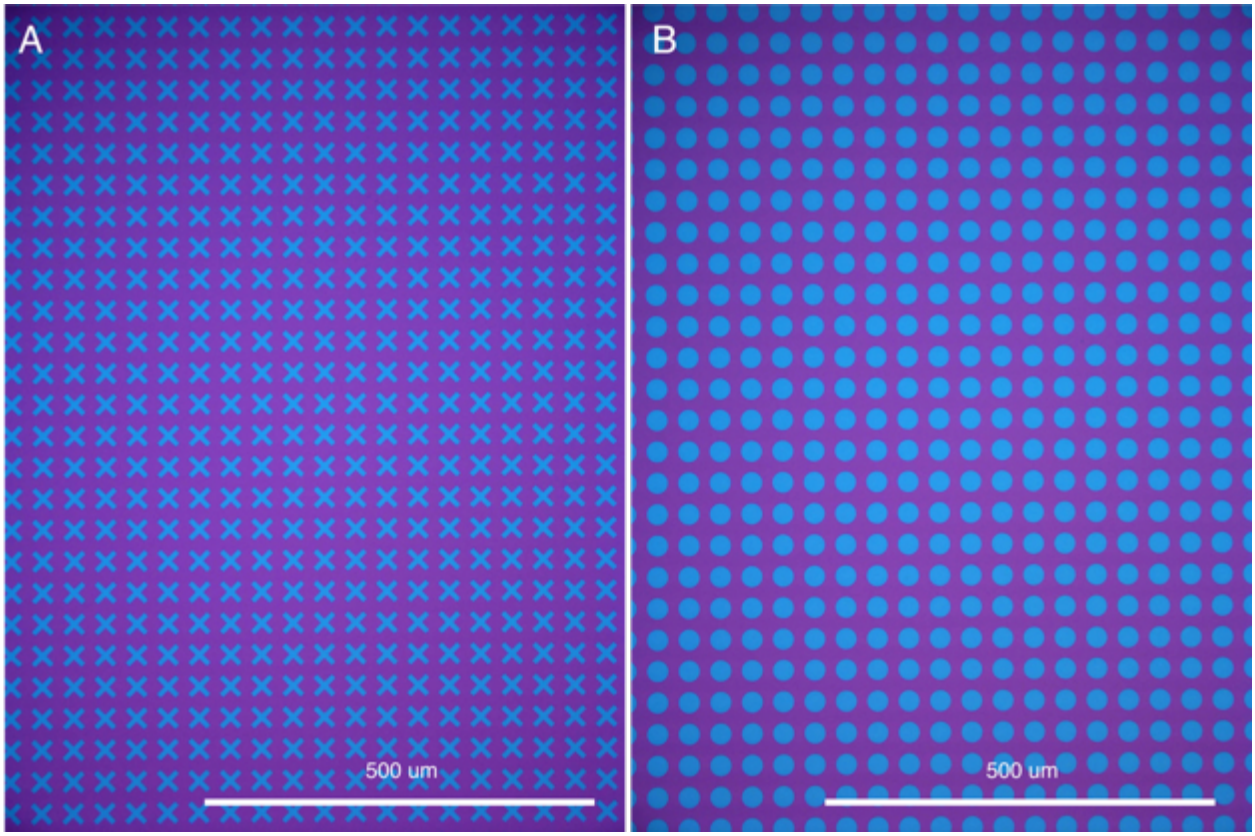

Figure S12. Optical images of PS-*hv*-PEO thin films printed with micropatterned PDMS stamp with (A) cross and (B) circle pattern.

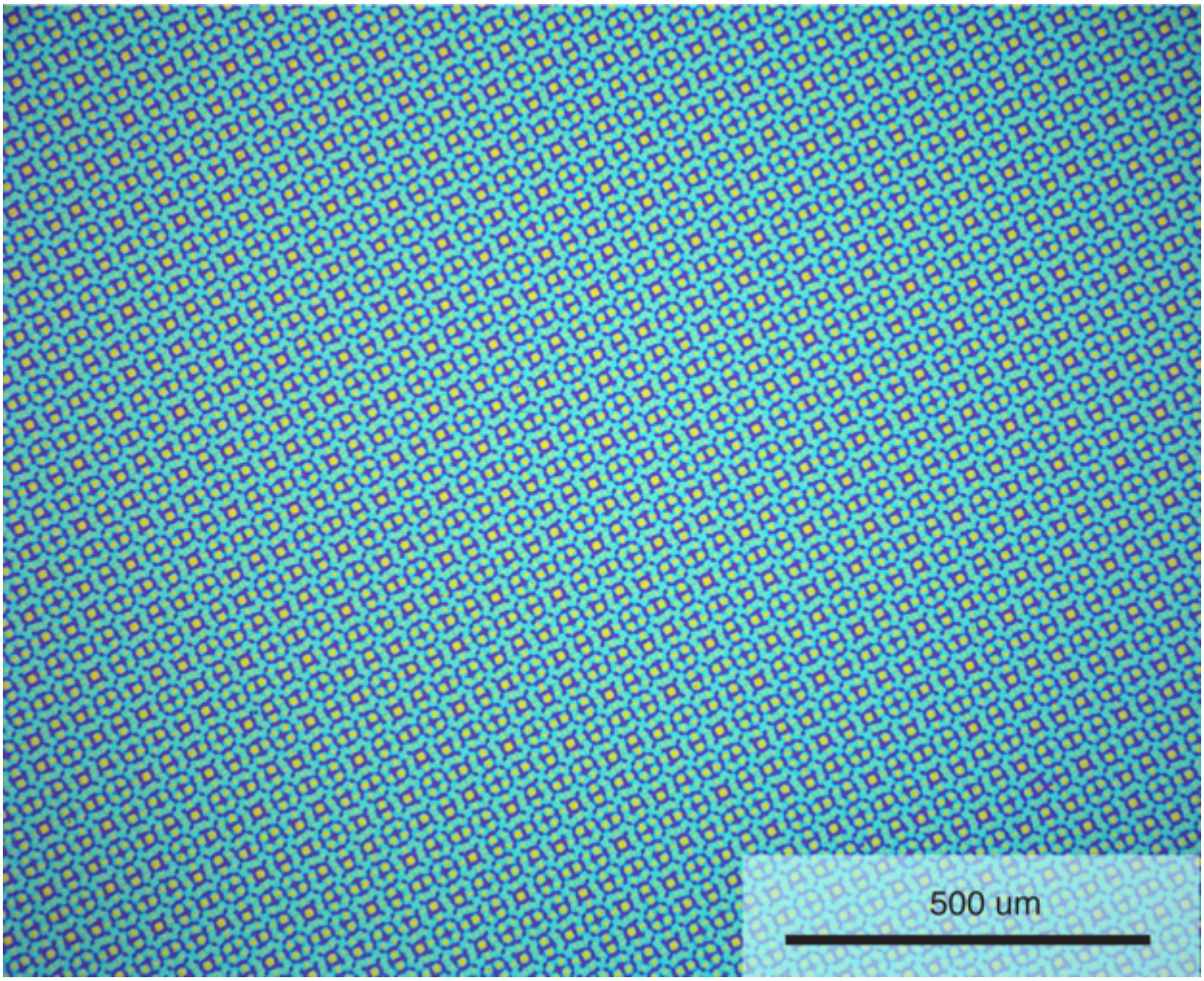

Figure S13. Optical images of PS-*b*-PEO thin films sequentially printed with micropatterned PDMS stamp with a square pattern.