Biomimetic microlens array with antireflective "moth-eye" surface

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1. Compound eye replication

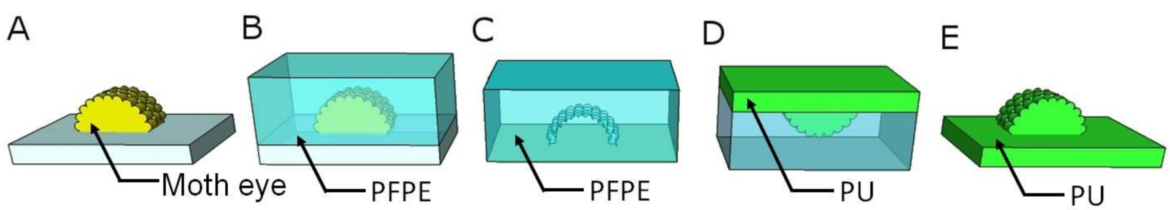

Figure S1: Schematic process for compound eye replication by PRINT. A) The rinsed moth eye was positioned on the substrate. B) The functionalized perfluoropolyether (PFPE) oligomer was poured on top of the moth eye and cured by UV light (λ=365 nm) for 6 minutes under a nitrogen purge. C) The cured PFPE mould which has inverse structure of compound eye was peeled off. D) The UV curable polyurethane (PU, Norland Products Inc., NOA 73) was placed to fill the prepared PFPE mould and polymerized for 5 minutes under a nitrogen purge. E) The PU replica was removed from the PFPE mould.

2. PDMS moulds of the compound microlens

Figure S2 presents further proof that the specifically-designed PFPE is more effective than using solely PDMS (polydimethylsiloxane, SYL-GARD 186 Silicone Elastomer) for moulding purposes. The mould shows the transferred structure of the compound microlens by the observations viewed via SEM. In SEM analysis, the PDMS mould shows excessive distortion and wrinkling whereas the PFPE mould captures the surface strucure without mutation (See Figure 1 in manuscript).

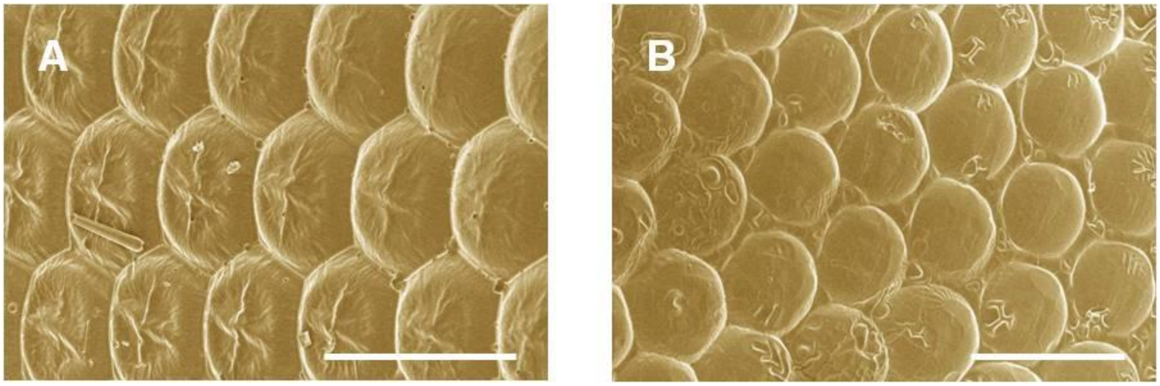

Figure S2: Scanning Electron Micrographs of A) The PDMS mould of *Sarcophagidae blaesoxipha* as polymerized at 105º C for 3 hours. B) The PDMS mould of *Sarcophagidae blaesoxipha* as polymerized at room temperature for 24 hours. All scale bars are 50 µm.

3. Optical properties of the used polyurethane (PU) film

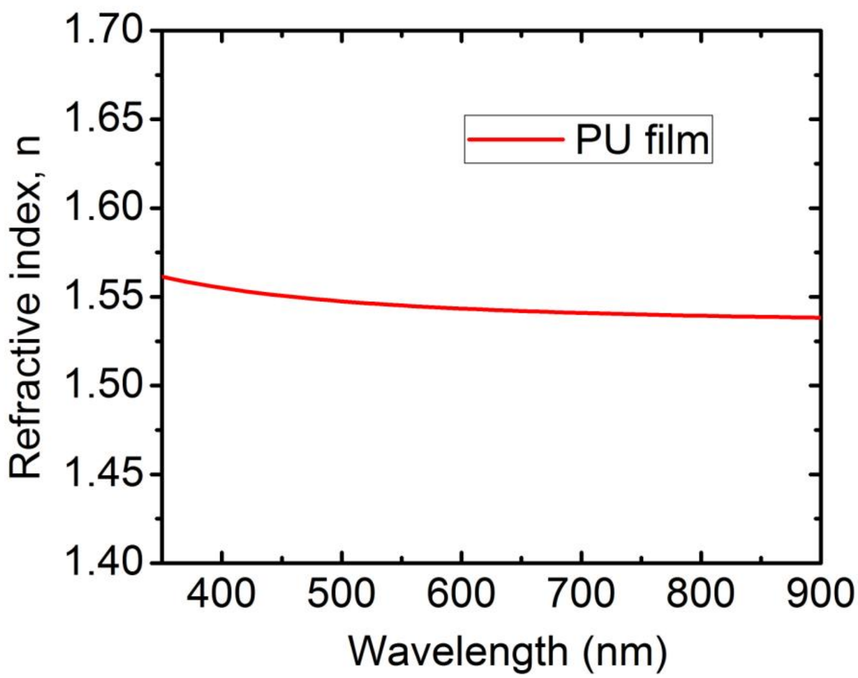

Figure S3; Refractive index of the used PU film measured via spectroscopic ellipsometry. A Cauchy model was assumed to obtain the refractive index from the ellipsometric data

4. Calculation for reflectivity of moth eye nanopatterns

Optical models for the moth eye antireflective nanostructures were generated using RSoft DiffractMOD. A hexagaonal array of slanted or trapezoidal posts with 200 nm periodicity and the optical properties of PU from Figure S3 are used. Along with the nanopattern periodicity, the diameter at the bottom of the posts (160 nm), diameter at the top of the posts (100 nm), and post height (130 nm) are similar to those measured via SEM. Reflectivity is simulated at normal incidence where negligable differences were noted in the calculation between p- and s-polarized illumination. On the other hand, the predicted reflection is influenced by the overall height of the nanopattern as shown in Figure S4. Reflectivity of posts with rounded tops of varying radius are shown to influence the reflection where the best fit to the measured data is obtained for smaller radius and consequently shorter post height.

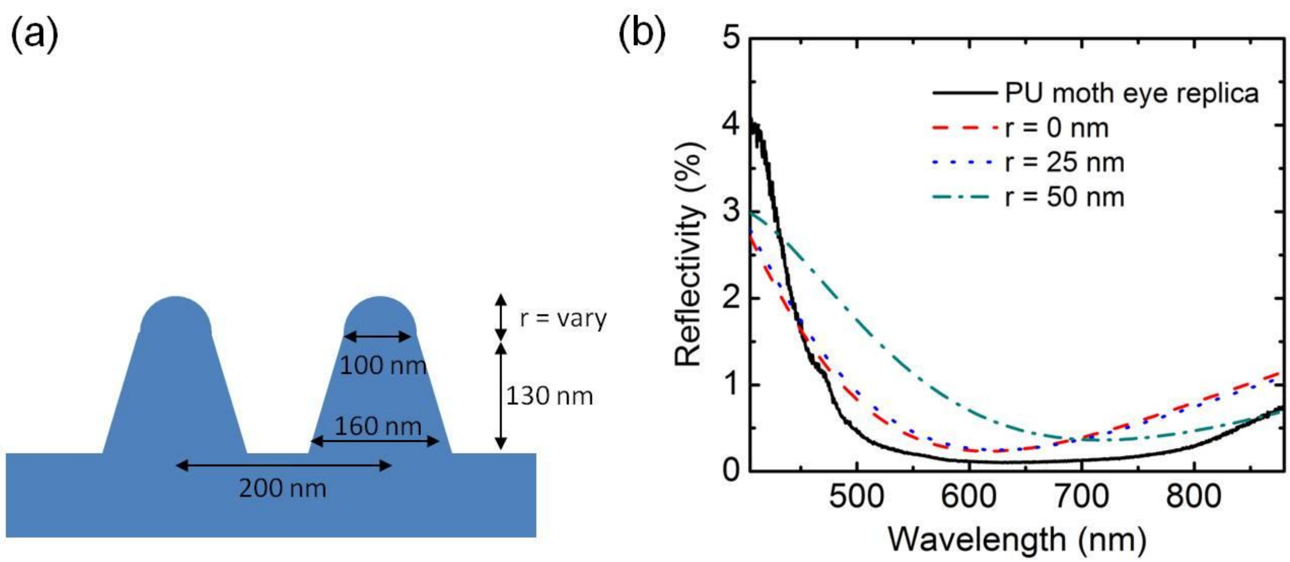

Figure S4: (a) Schematic of antireflective nanopatterns for calculation of moth eye reflection. Slanted or trapezoidal shaped posts are considered with rounded tops of different radii. (b) Measured reflectivity for unpolarized light at normal incidence for the PU moth eye replica along with calculations for the various nanostructures.

5. P3HT:PCBM moth eye replica

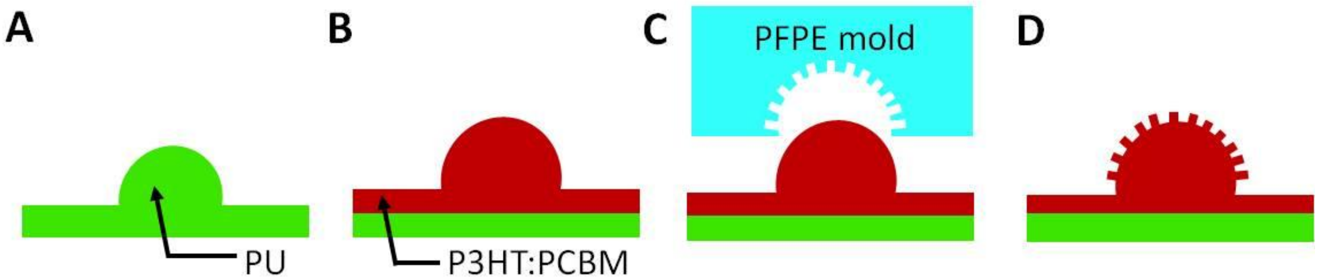

Figure S5: Schematic process for P3HT:PCBM moth eye replication by PRINT. A) A PU sphere identical to the moth eye size is prepared by PRINT by using a comparable size of ball bearing. B) The P3HT:PCBM (=1:0.8) solution in chlorobenzene was spincast on the PU sphere substrate. C) The new film is patterned with the prepared moth eye PFPE mould under pressure at 145 °C for 30 min. D) The PFPE replica was peeled off the substrate to give highly ordered and regular 3D microlens with nanopatterns.