- Supplementary information -

Conjugated Polymer Coating Enabled Light-resistance Black Phosphorus with Enhanced Stability

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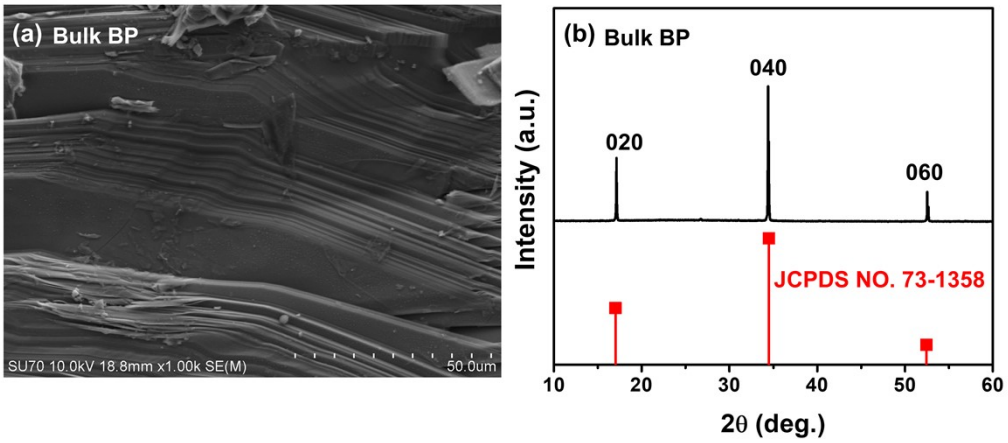

Figure S1. (a) SEM image of the as-prepared bulk BP showing the layered structure of BP. (b) XRD patterns of the as-prepared bulk BP. Bar diagram for the JCPDS of BP.

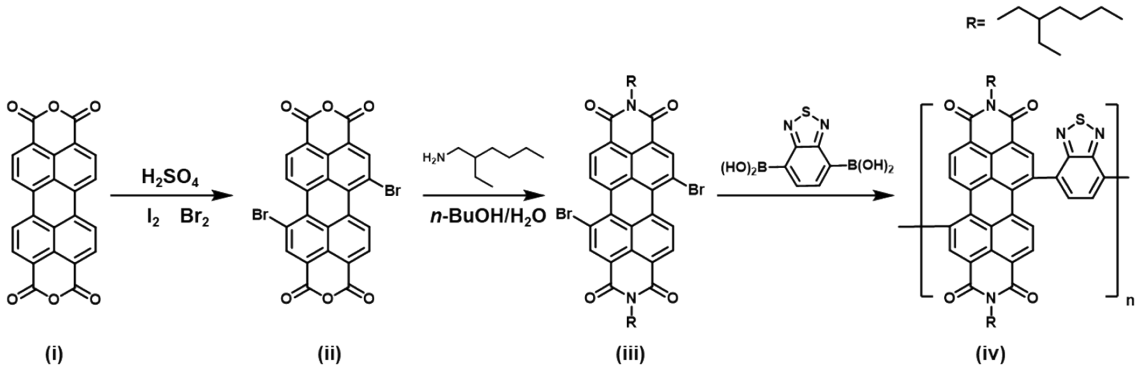

Figure S2. Schematic illustration of the synthesis of light-absorbing conjugated polymer.

Synthesis of conjugated polymer. A mixture of perylene-3,4,9,10-tetracarboxylic acid bisanhydride (i, 2.0 g, 5.098 mmol) and 98wt% sulfuric acid (55.2 g) was added in a 250 ml three-neck flask and stirred for 3 h at room temperature, and subsequently I_2 (45 mg, 0.191 mmol) was added. The reaction mixture was heated to 80 °C, then bromine (1.7925 g, 11.2156 mmol) was added dropwise in a slow interval. After the reaction at 80 ℃ for 4 h, the mixture was cooled to room temperature. 4.5 g water was

added slowly and carefully. The obtained precipitate was separated by filtration through a G4 funnel, washed with a large amount of water, and dried in a vacuum to give 2.451 g (yield 86%) of a red solid (ii).

A mixture of ii (2.8 g, 5.098 mmol) and 350 mL of *n*-BuOH/H_2O (1:1, v/v) were placed in a 500 ml three-neck flask, and subsequently sonicated for 10 min. Then, 2-ethylhexylamine (2.924 ml, 17.892 mmol) was added and the reaction mixture was stirred at 80 ℃ for 24 h with nitrogen purged. After addition of concentrated HCl (17 mL), the resulting mixture was stirred at room temperature for 30 min, and then diluted with Chloroform. The mixture was washed with water and extracted with Chloroform for three times. The organic layer was washed with brine and dried over $MgSO_4$. After solvent was evaporated, the residue was purified by column chromatography (silica gel; eluent: chloroform). The target product was collected and dried in a vacuum to give 2.1 g (yield 53%) of a red solid (iii). ^{1}H NMR ($CDCl_3$, 500M Hz, TMS, 298K): δ(ppm) 9.47 (d, *J*=10, 2H), 8.91 (s, 2H), 8.69 (d, *J*=10, 2H), 4.15 (m, 4H), 1.95 (m, 2H), 1.42-1.25 (m, 16H), 0.95 (t, *J*=10, 6H), 0.9 (t, *J*=10, 6H)

Then, compound iii (97 mg, 0.1225 mmol), 4,7-Bis(4,4,5,5-tetramethyl-1,3,2-dioxaborolan-2-yl)-2,1,3-benzothiadiazole (48.706 mg, 0.1225 mmol), K_2CO_3 (104.072 mg, 0.753 mmol) and one drop of methyltrioctylammonium chloride were placed in a 25 ml three-neck flask, and $Pd(PPh_3)_4$ (4.35 mg, 0.003675 mmol) were placed in the flask quickly. The reaction container was purged with N_2 for 30 min to remove O_2. Subsequently, 10 ml deoxidized toluene/water solution (4:1, v/v) was added. The resulting mixture was stirred at 80 °C for 60 h, and then diluted with

Chloroform. The mixture was washed with water and extracted with Chloroform three times. The organic layer was wash with brine and dried over $MgSO_4$. After solvent was evaporated, product was purified by reprecipitation (Chloroform / methanol = 5 mL / 40 mL). Finally, after filtration and vacuum drying, 192 mg violet black solid was obtained (iv).

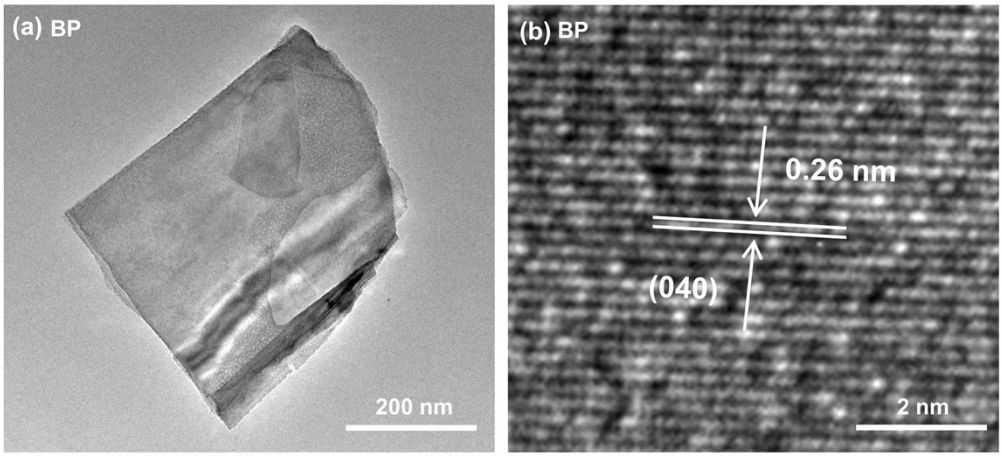

Figure S3. (a) TEM image of the as-prepared BP nanosheet. (b) HRTEM image of the as-prepared BP nanosheet.

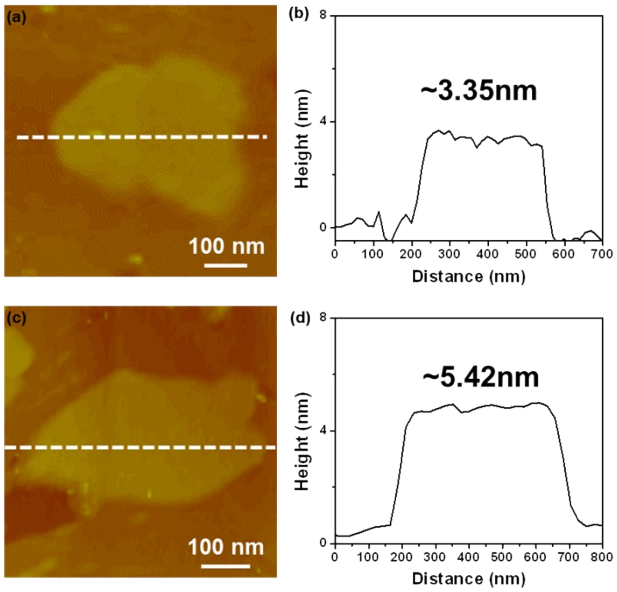

Figure S4. (a) AFM image of BP. (b)The height profile along the white line. (c) AFM image of BP/Polymer when the amount of conjugated polymer was increased in synthesis and (d) the corresponding height profile along the white line.

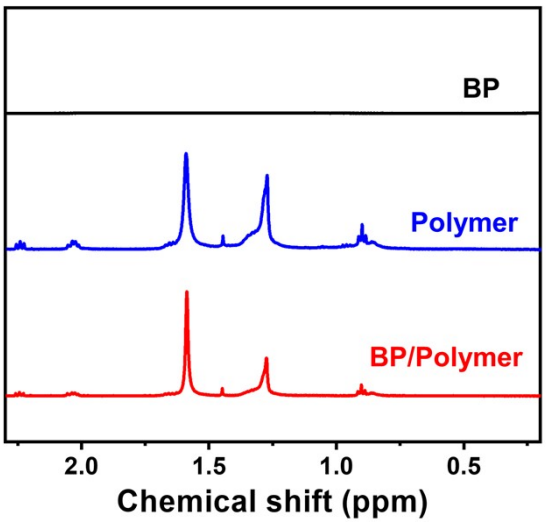

Figure S5. ^{1}H NMR spectra of BP, conjugated polymer, and BP/Polymer.

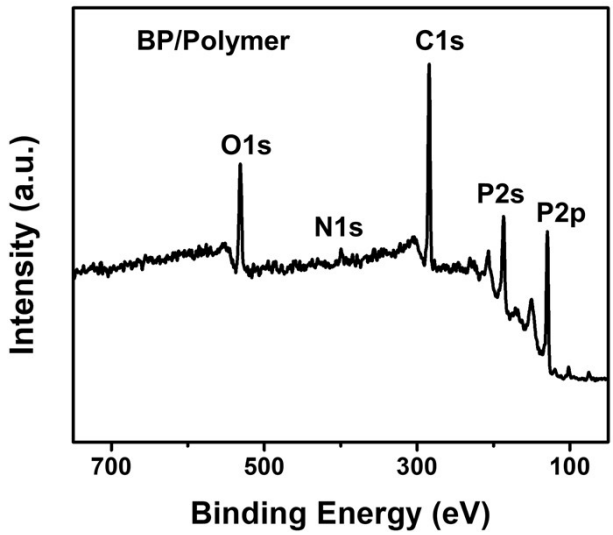

Figure S6. Full XPS spectrum of the as-synthesized BP/Polymer.

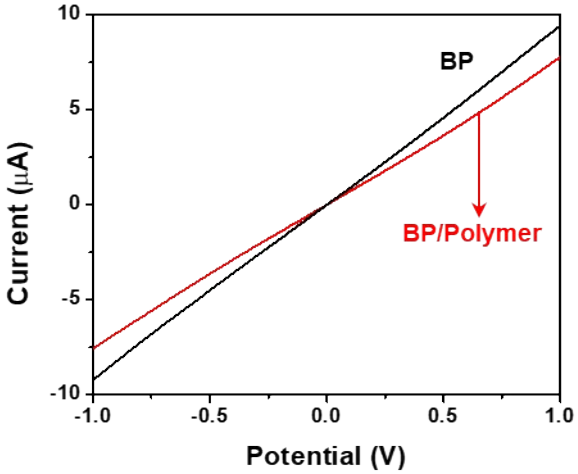

Figure S7. Conductivity test results of BP and BP/Polymer.

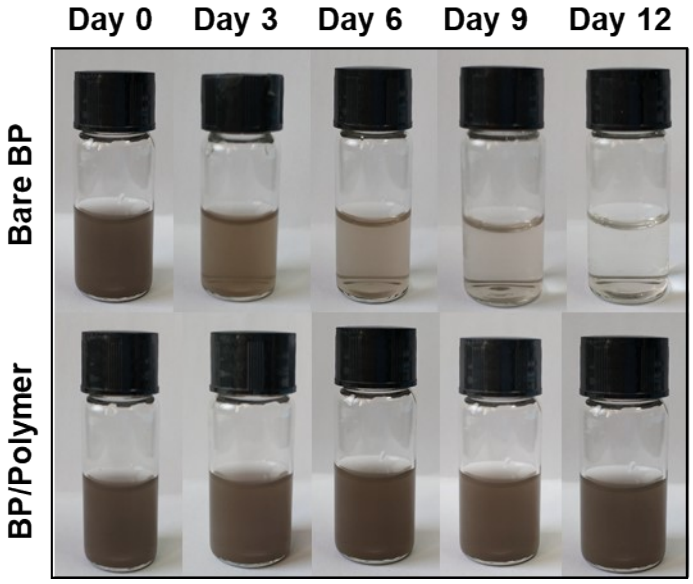

Figure S8. The color change of BP/Polymer and BP NSs dispersion under sunlight recorded by camera.

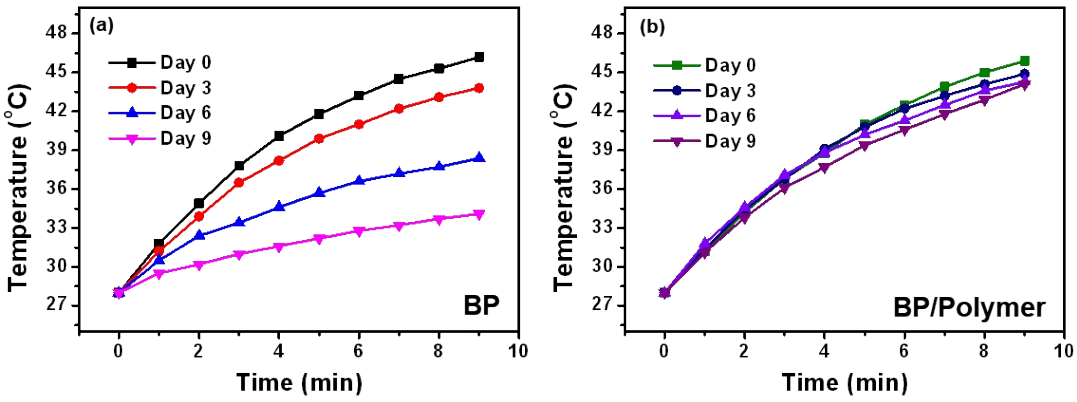

Figure S9. Photothermal heating curves of BP and BP/Polymer after storing in water for 0, 3, 6, and 9 d using the 808 nm laser as the irradiation source.

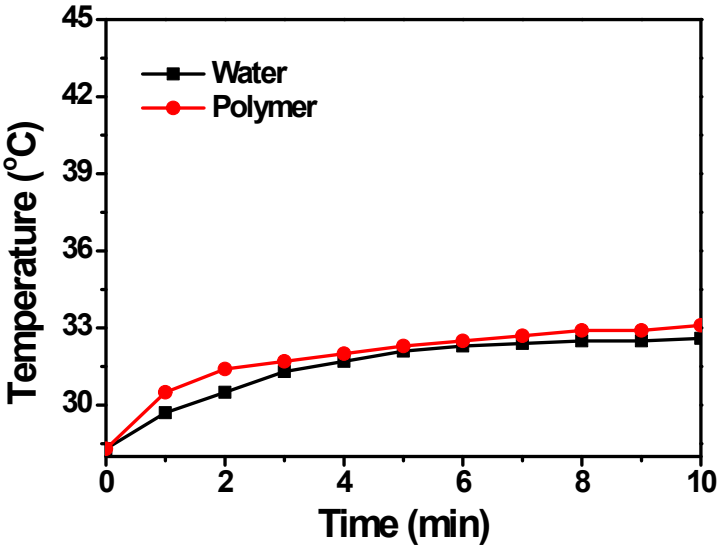

Figure S10. Photothermal heating curves of polymer dispersion and pure water using the 808 nm laser as the irradiation source.