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Scalable Superhydrophobic Coatings with Recycled Polypropylene

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Experimental

Materials and chemicals

Discarded Falcon® conical centrifuge tubes (15 mL or 45 mL) were used as polypropylene (PP) source. They were cleaned and chopped into small scraps (about 1 cm × 1 cm) for oxidation reactions. Potassium persulphate ($K_2S_2O_8$) and other chemicals are purchased from Sigma-Aldrich.

Polypropylene oxidation

A molten plastic method was used for polypropylene oxidation. Approximately 2.0 g of PP scraps and 1 wt% of potassium persulphate were loaded into a 20 mL open vial and heated to 220 °C. At this temperature, the PP plastic melted, and the reaction mixture was stirred for 6 hours to facilitate the oxidation. The resulting product, partially oxidized polypropylene (OPP), was utilized as the material for the coating process.

Coating

For spray coating, the partially oxidized polypropylene (OPP) was dissolved in toluene at 10 mg/mL. The solution could be stable at room temperature for several hours (3 ~ 5 h) before use. A spray gun was used to spray the OPP in

toluene solution, the working pressure of compressed air for spray is about 45 psi. The spray distance is about 30 cm. For dip coating, OPP concentrations of 20 ~ 40 mg/mL were employed, and the solution temperature was elevated to 60 °C to ensure good solubility. The fabric was submerged into the OPP solution for one minute before being removed. All coatings were dried at 80 °C overnight. Durability test for OPP coated fabric was conducted by rubbing OPP coated fabric with tissue paper; one rub consisted of one back-and-forth abrasion.

Materials characterizations

The SEM images were taken with a JEOL JSM 7500 scanning electron microscope. FT-IR spectra were collected on the PerKinElmer Spectrum 100 FT-IR Spectrometer. Water contact angles and rolling angles were determined using a DataPhysics TBU100 contact-angle measuring system under ambient conditions. Droplets (3 ~ 6 μL) of deionized water were placed on the samples using a micro-syringe. A minimum of five readings were taken from different positions of each sample. Powder X-ray diffraction (XRD) experiments were conducted on Bruker D8 Advance.

Table S1. Solubility test of PP and OPP in common solvents.

		1 mg/mL				5 mg/mL				10 mg/mL			
Solvent	Substrate	22°C	50°C	80°C	BP	22°C	50°C	80°C	BP	22°C	50°C	80°C	BP
xylene	PP	x	✓	✓	✓	x	x	x	✓	x	x	x	✓
	OPP	x	✓	✓	✓	x	✓	✓	✓	x	x	✓	✓
toluene	PP	x	✓	✓	✓	x	x	✓	✓	x	x	x	✓
	OPP	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
MIBK	OPP	x	x	x	✓	x	x	x	✓	x	x	x	✓

Boiling point (BP) of solvent: xylene 138 °C; toluene 110 °C; methyl isobutyl ketone 116 °C.

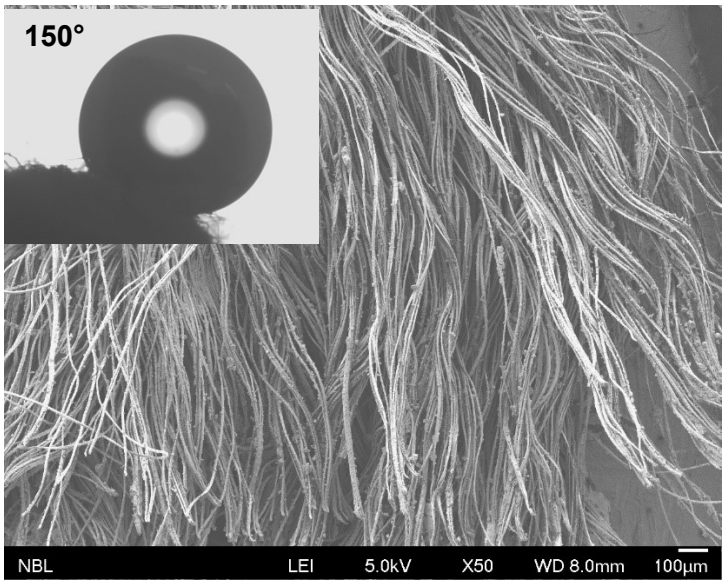

Figure S1. Dip coating of a fabric substrate (initially superhydrophilic, absorbs water entirely) using methyl isobutyl ketone (MIBK) as a solvent. OPP/MIBK concentration: 20 mg/mL; temperature 100 °C. The coated sample was dry in oven at 80 °C for 16 hours.

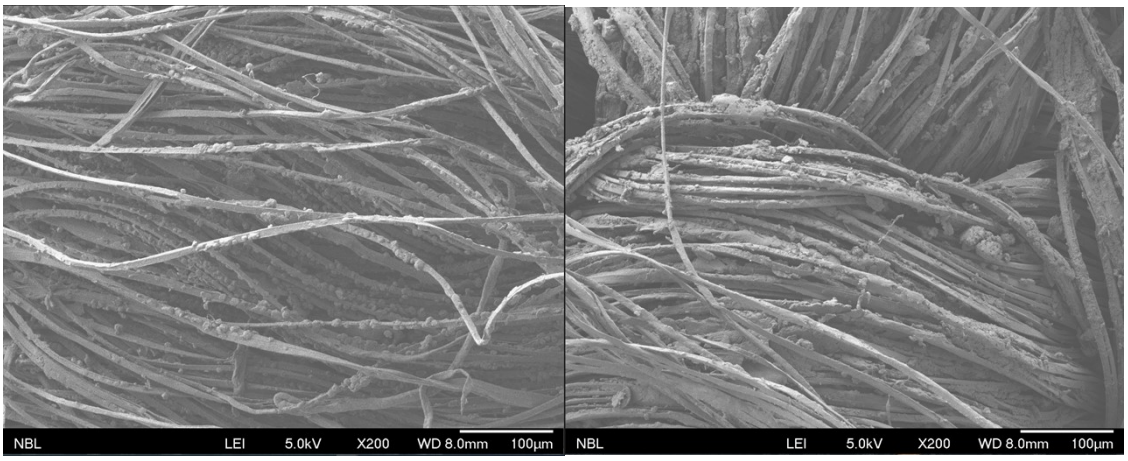

Figure S2. SEM images of OPP coated fabrics after 500 rubs, showing PP particles adhered to the fibres after the abrasion test. A) Dip coated. B) Spray coated.