Supplementary Online Material (SOM)

Materials and Methods

Materials. Granular i-PP was purchased from Aldrich (Cat no: 18,238-9) and had M_w = 250,000 g/mole as determined by gel-permeation chromatography. (T_g = -26 ^oC, T_m = 189 ^oC, d = 0.9 g/cm^3). p-xylene was used as the good solvent. Methyl ethyl ketone (MEK), cyclohexanone and isopropyl alcohol were investigated as the non-solvent (precipitator).

Coating preparation. i-PP was slowly dissolved in fixed volume of p-xylene in a test tube sitting in silicone oil bath at 130 ^oC. Few drops of the polymer solution were then put onto glass slides which were used as received without any chemical treatment. The solvent was evaporated at constant temperature in a vacuum oven. Polymer concentrations of 10-40 mg/ml, film formation temperatures of 30-90 ^oC were applied and the effect of the presence of MEK, cyclohexanone and isopropyl alcohol non-solvents on the homogeneity, surface roughness and the water contact angle of the i-PP coating were investigated.

Characterization methods. The homogenetiy of i-PP films and film thicknesses were determined by Leica DMLM optical microscope. The morphology was observed by scanning electron microscope (JEOL, JSM-840A) and the surface roughness was quantified by atomic force microscopy, AFM, (NT-MDT Solver P47). AFM pictures were taken in tapping mode using ultra-sharp silicon cantilevers having force constants of 3 N/m or 48 N/m. For nano-scale wear investigation, AFM was used in contact mode with 48 N/m silicon cantilever. Contact angle measurements were carried out by applying a video microscope interfaced to a personal computer similar to our previous studies (S. 1, 2).

Durability. The thickness of the films ranged between 10-100 μm depending on the solution concentration and preparation conditions. The durability of the coatings on glass substrates and their super-hydrophobicity have been investigated in terms of adhesion, compressive forces, ambient temperature, nano-scratch resistance and contamination.

Adhesion. The coatings stay very robust on the substrates for more than a week when soaked in water and in heptane indicating a strong adhesion to the underlying substrate. The coatings kept in boiling water for 30 min. also did not debond. The sides of the coatings facing the glass substrate were investigated by AFM after peel-off. Those sides were very smooth indicating a contact area with the substrate that is equal to the apparent area of the coating. The adhesive peel-off force in the normal direction between the coating and the glass substrate was measured using a sensitive balance and was found to have a value of 0.13 ± 0.01 N for the smallest velocities. The coated glass substrates were fixed on the top surface of an electronic balance (Scaltec SPB31) having a sensitivity of 1 μN. An adhesive tape having a width of 12 mm was placed on the coating and peeled-off in a direction perpendicular to the substrate. The force during the adhesive failure between the coating and the glass substrate was recorded and averaged for different samples.

Compressive forces. Compressive forces up to 1000 N were applied by putting masses on the coatings. Larger forces were applied using a Perkin Elmer Hydraulic Press. Water contact angles were measured after application of compressive forces. Fig. S1 shows water contact angle as a function of applied compressive pressure (compressive force divided by the apparent area) in the normal direction for a coating with an initial contact angle of 152°. Any decrease in the water contact angle was not observed up to 5 MPa.

Ambient temperature. The coatings were kept at temperatures between -20 °C and 160 °C for several hours to several days and water contact angles were measured after each temperature. Any decrease in water contact angle was not observed up to 160 °C, close to the melting temperature of i-PP. At 160 °C, i-PP melted and water contact angle decreased to 90-100°.

Nano-scratch tests. Nano-scratch tests were done by AFM (S. 3) using Si tips. A 10 μm x 10 μm area was scratched in contact mode at different normal forces. After scratching, the height and phase image of 40 μm x 40 μm area containing the scratched area were taken in tapping mode to detect any possible wear. Fig. S2 shows AFM height & phase images of the coating initially, and after scratching at normal forces of 11.3 and 12.6 μN (Fig. S2(A), (B), and (C), respectively) together with AFM height image of an i-PP film obtained from melt and scratched at a normal force of 6.3 μN (Fig. S2(D)). No detectable wear in the scanned area has been observed for super-hydrophobic i-PP coatings up to a normal force of 11.3 μN indicating a good wear resistance of the coating at the nano-scale. The area scratched at a normal force of 6.3 μN on i-PP film obtained from melt is clearly seen in Fig. S2(D).

Contamination. Signs of contamination were not observed for coatings kept for 2 months in ambient atmosphere at relative humidity less than 40 % and in the temperature range of 15-30 °C. Samples that have been kept under extreme ambient conditions of warmer than 30 °C and more than 80% relative humidity showed a contact angle decrease of 10-20° after 3 months. This decrease is attributed to the hydrophilicity of the underlying substrates.

References:

S.1. H. Y. Erbil, in *Handbook of Surface and Colloid Chemistry*, K. S. Birdi, Ed. (CRC Press Inc., Boca Raton, 1997), Chap. 9.

S.2. H. Y. Erbil, G. McHale, M. I. Newton, *Langmuir* **18**, 2636 (2002).

S. 3. M. Scherge, S. Gorb, *Biological Micro- and Nano- Tribology* (Springer-Verlag, Berlin, 2001) p. 166.

Supporting Figures

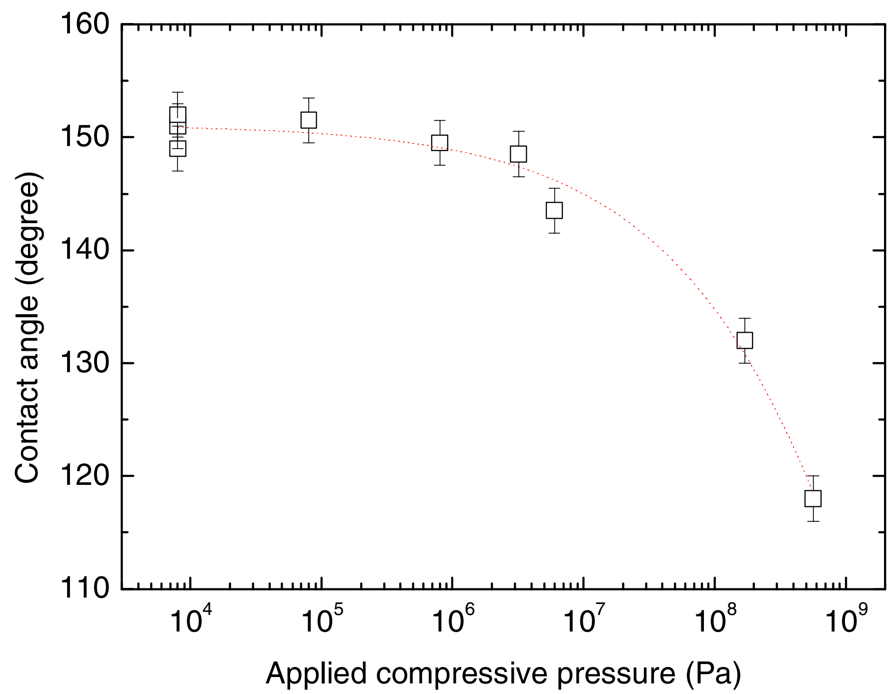

Fig. S1. The effect of applied compressive forces on the water contact angles. The pressure was calculated by dividing the force by the apparent area of the film.

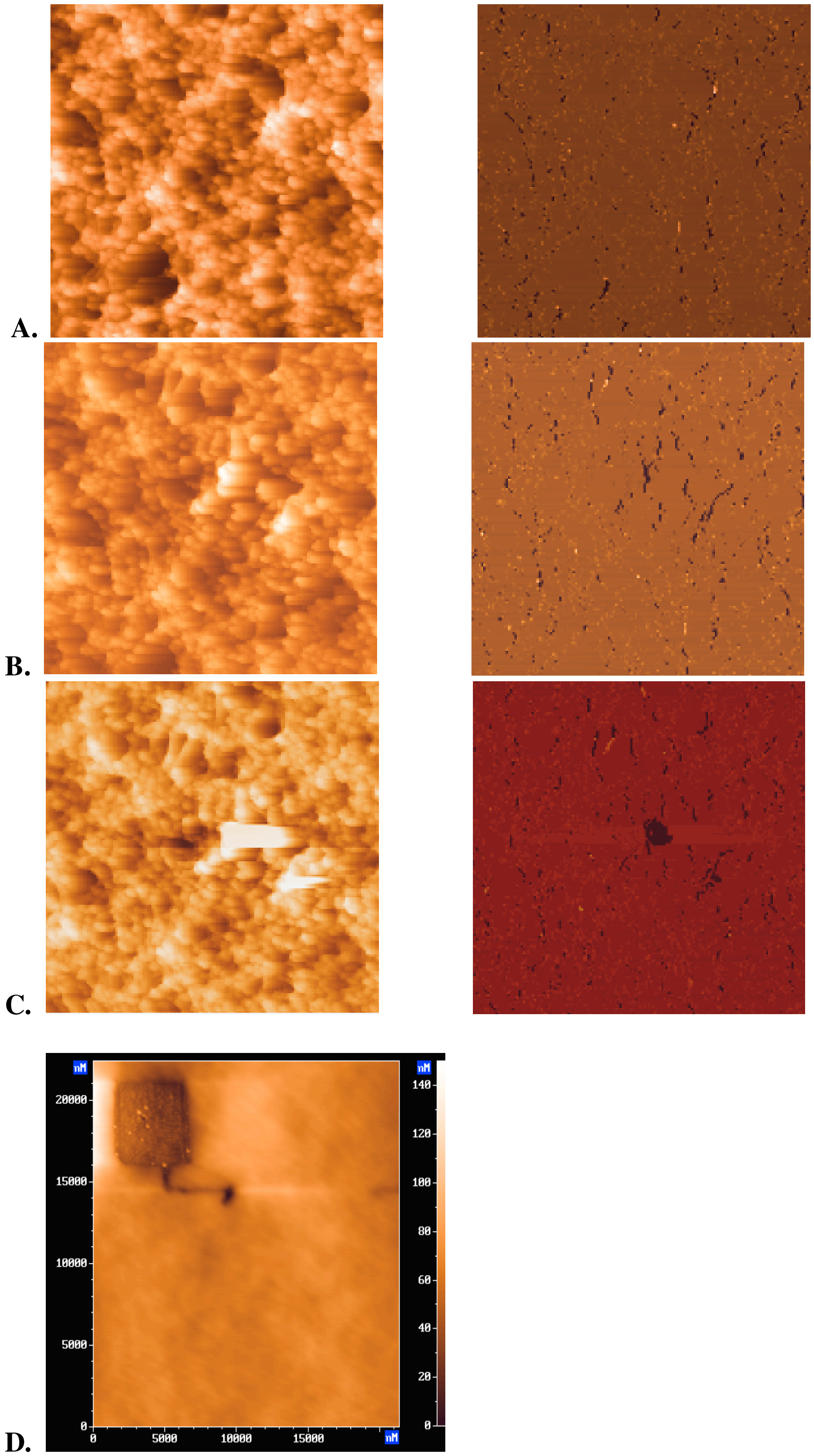

Fig. S2. (A) Height & Phase image of 40x40 μm^2 area initially. **(B)** Height & Phase image of the area in (A) after scanning with 11.3 μN. **(C)** Height & Phase image of the area (A) after scanning with 12.6 μN. Wear is seen in both height & phase image. **(D)** Height image of an i-PP film from melt after scanning with 6.3 μN.