Self-assembled and Elastomeric Arm Decorated Surfaces for High Stress

Resistant Super-repellent Materials

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Supporting Information

Barendson equation to estimate the grafting density $\propto = \frac{10^{6} P_{c}}{1200 n_{c} - P_{c} M_{1}} \cdot \frac{1}{S_{BET}}$ Where P_c= 4.6, n_c= 30, M₁= 800, S_{BET}= 134.5 $N = \propto N_{A} / 10^{24}$ Where N_A= 6.023×10²³

SI1. Equation used for the estimation of grafting density of SOS particles.

SI2. Equations for calculation of surface energy

$$\gamma_{L}(1 + \cos \theta) = 2\sqrt{(\gamma_{S}^{d} \gamma_{L}^{d})} + 2\sqrt{(\gamma_{S}^{p} \gamma_{L}^{p})}$$
(1) OWRK method
$$\gamma_{L}(1 + \cos \theta) = 4 \left[(\gamma_{L}^{d} \cdot \gamma_{S}^{d} / \gamma_{L}^{d} + \gamma_{S}^{d}) + (\gamma_{L}^{p} \cdot \gamma_{S}^{p} / \gamma_{L}^{p} + \gamma_{S}^{p}) \right]$$
(2) harmonic mean method



SI3. FESEM images of (a) SP (b) ASP particles.

SI4. Static contact angle of different SOS-(PVDF-co-HFP) coatings with various liquids

FPS coating	Static contact angles of various liquids				
	Water (°)	Glycerol (°)	Honey (°)	Ethylene	
				glycol (°)	
35 FPS	164±1	161±2	159±2	154±2	
45 FPS	167±1	162.5±1	160±2	157±2	
55 FPS	166±1	164±1	159±2	155±2	
65 FPS	167±1	162±1	162±1	157±2	

SI5. Relative percentage of elements present on the surfaces SOS particles and 45 FPS coating.

	SOS particles (atomic conc. %)		45 FPS (atomic conc. %)	
Peak	Quantification by	Quantification by	Quantification	Quantification
	area	intensity	by area	by intensity
C 1s	41.03	38.85	32.18	26.64
O 1s	37.89	39.69	7.59	7.95
N 1s	4.27	3.61	0.00	0.79
Si 2p	16.81	17.85	2.85	3.11
F 1s	not detected	not detected	57.37	61.52



SI6. XPS analysis of C 1s on SOS particles and 45 FPS coating



SI7. Particle size analysis of sand particles by DLS method.

Impingement energy calculation on 45 FPS coating at different heights

The impingement energy by the sand particles is given by $Ws = (4/3) \prod R^3 \rho gh$ (*Ref: Li, Y.; Chen, S.; Wu, M.; Sun, J., All Spraying Processes for the Fabrication of Robust, Self-Healing, Superhydrophobic Coatings. Adv. Mater. 2014, 26 (20), 3344-3348)*

Where ρ = density of silica = 2g/cm³

g= acceleration due to gravity= 9.8 m/s²

R= radius of the sand grains= 163.5 μ m (volume weighted mean from particle size analysis)

h= height used to release sand particles

At height (h) = 0.2 m, $W_s = 0.71 \times 10^{-7}$ J/grain At height (h) = 0.4 m, $W_s = 1.43 \times 10^{-7}$ J/grain At height (h) = 0.6 m, $W_s = 2.15 \times 10^{-7}$ J/grain At height (h) = 0.8 m, $W_s = 2.87 \times 10^{-7}$ J/grain At height (h) = 1.0 m, $W_s = 3.6 \times 10^{-7}$ J/grain

SI8. Calculation of impingement energy at different heights on 45 FPS coating.



SI9. Optical images display the retention of super-repellent nature on 45 FPS coating after sand impingement test.

Water hammer pressure on 45 FPS coating at different heights

The water hammer pressure created by the water droplets is given by (*Ref: Y Huang, Y. C.; Hammitt, F.; Yang, W., Hydrodynamic phenomena during high-speed collision between liquia droplet and rigid plane. Journal of Fluids Engineering* **1973,** 95 (2), 276-292)

The velocity of water droplet $V = (2gh)^{\frac{1}{2}}$ (for freely falling body) (Initial (potential energy+ kinetic energy) =Final (PE +KE) $mgh + 0 = 0 + (0.5 \text{ mv}^2)$ i.e. $mgh=0.5 \text{ mv}^2$, hence $V = (2gh)^{\frac{1}{2}}$ Water hammer pressure, $P_h = 0.2 \rho C V$ where $g = 9.8 \text{ m/s}^2$, $\rho =$ density of water= 1000kg/m³ C= velocity of sound in water at 28 °C=1500 m/s V= velocity of water For height (h) = 0.2 m, Velocity= 2 m/s, *Water hammer pressure*, P = 600 KPaFor height (h) = 0.4 m, Velocity= 2.8 m/s, *Water hammer pressure*, P = 840 KPaFor height (h) = 0.6 m, Velocity= 3.43 m/s, *Water hammer pressure*, $P = 1029 \text{ KPa} \sim 1.03MPa$ For height (h) = 0.8 m, Velocity= 3.96 m/s, *Water hammer pressure*, $P = 1188 \text{ KPa} \sim 1.2MPa$ For height (h) = 1.0 m, Velocity= 4.43 m/s, *Water hammer pressure*, $P = 1329 \text{ KPa} \sim 1.33MPa$

SI10. Calculation of water hammer pressure at different heights on 45 FPS coating.



SI11. Static contact angle (i) pH=1 (ii) pH=7 (iii) pH=13 (iv) honey (v) glycerol and (vi) ethylene glycol of (a) original 45 FPS coating (b) after sand impingement treatment (c) after water impalement treatment.



SI12. (a) Experimental setup to determine the abrasion resistance of 45 FPS coating (b) water repellency of 45 FPS coating after different no. of abrasion treatments.