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Electronic Supplementary Information

Permanently Grafted Icephobic Nanocomposites with High Abrasion Resistance

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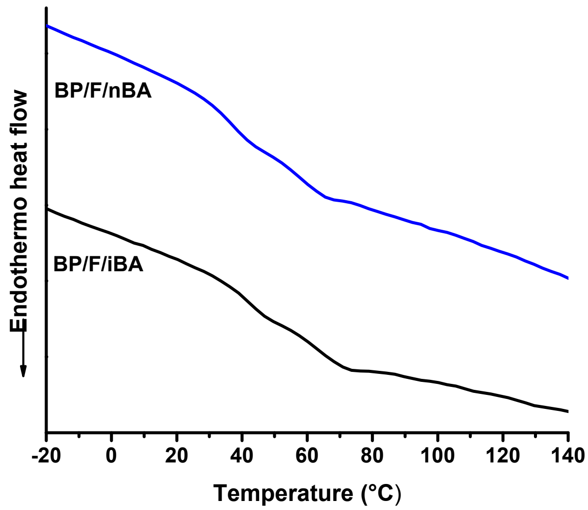

Fig. S1 DSC thermograms of the two terpolymers.

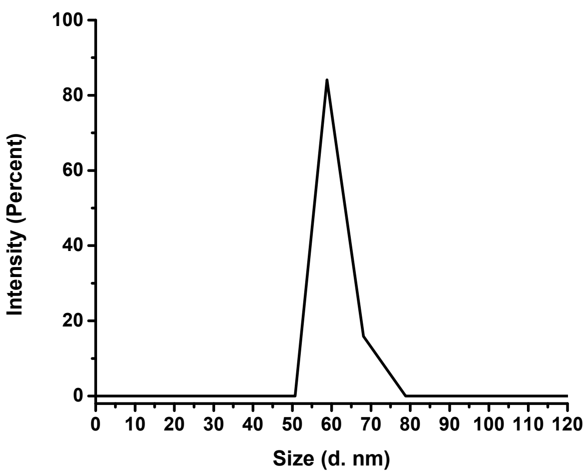

Fig. S2 Size distribution of the unfunctionalized silica nanoparticles measured by DLS. The mean particle diameter is 60.2 ± 3.4 nm.

Calculation of icing possibility, f

Based on the three-dimensional heterogeneous nucleation on a foreign particle,[1] the free energy of formation of an embryo on the foreign particle is

$$\Delta G_c = \Delta G^{homo}_c f(m,x) \quad (1)$$

Here ΔG_c is the free energy barrier of heterogeneous nucleation, and ΔG^{homo}_c corresponds to the free energy barrier of homogeneous 2D nucleation. $f(m,x)$ is a dimensionless factor that determines ΔG_c. It can be calculated by as

$$f(m,x) = \frac{1}{2} + \frac{1}{2}(\frac{1-mx}{w})^3 + \frac{1}{2}x^3\left[2 - 3\left(\frac{x-m}{w}\right) + \left(\frac{x-m}{w}\right)^3\right] + \frac{3}{2}mx^2\left(\frac{x-m}{w} - 1\right) \quad (2)$$

where

$$m = \cos\theta_{flat} \quad (3)$$

$$x = {}^{R}/_{r_c} \quad (4)$$

and

$$w = (1 + x^2 - 2xm)^{1/2} \quad (5)$$

θ_{flat} is the static CA of the flat surface and is 105° for our cross-linked p(BP/F/iBA) surface. R is the radius of the foreign particle, r_c is critical radius of ice embryos and determined as following

$$r_c = 2\Omega\gamma_{cf}/\Delta\mu \quad (6)$$

where γ_{cf} is crystal-fluid (ice-water) surface energy (0.034 J m^{-2}, Ketcham and Hobbs, 1969)[2], Ω is water molar volume (1.8 x 10^5 m^3 mol^{-1}), and $\Delta\mu$ is difference in chemical potential of ice crystal structural units and water growth units, which approximates to

$$\Delta\mu \cong C_p T(\ln\left({}^{T}/_{T_m}\right) + \frac{T_m}{T} - 1) \quad (7)$$

Under our icing experimental condition, T is 255 K, T_m is 273 K, and C_p is approximately 75.3 J mol^{-1} K^{-1}.Therefore, $\Delta\mu$ is calculated to be 45.66 J mol^{-1} and r_c is 26.8 nm.

References

(1) Liu, X. Y. A New Kinetic Model for Three-Dimensional Heterogeneous Nucleation. *J. Chem. Phys.* **1999,** *111*, 1628-1635.

(2) Ketcham, W. M.; Hobbs, P. V. An Experimental Determination of the Surface Energies of Ice. *Philos. Mag.* **1969,** *19*, 1161-1173.