Electronic Supplementary Material (ESI) for ChemComm.

Supporting Information

Room-temperature Endogenous Lubricant-infused Slippery Surfaces by Evaporation Induced Phase Separation

Hao-Cheng Yang*[a,b†], Hai-Yuan Yuan[b†] , Zhen-Wei Wu[b] and Zhi-Kang Xu*[a,b]

[a] *MOE Key Laboratory of Macromolecular Synthesis and Functionalization, Key Laboratory of Adsorption and Separation Materials & Technologies of Zhejiang Province, Department of Polymer Science and Engineering, Zhejiang University, Hangzhou 310000, P. R. China*

[b] *The "Belt and Road" Sino-Portugal Joint Lab on Advanced Materials, International Research Center for X Polymers, Zhejiang University, Hangzhou 310000, P. R. China.*

[c] *School of Chemical Engineering and Technology, Sun Yat-sen University, Zhuhai 519082, China*

Experimental Section

2.1 Chemicals and materials

Ethylene-propylene copolymer (EPC) and n-Hexane (98%) were purchased from Macklin (China). Caprylyl methicone (BT-6034, viscosity: 4-5 mPa·s) was obtained from Guangzhou Bataichem Company. Other chemicals, such as ethanol and acetone, were provided by Sinopharm. All chemicals were used as received.

2.2 Fabrication of eSLIPS Coatings

To create the eSLIPS, EPC was dissolved in a mixture of caprylyl methicone and n-hexane at 50 °C with stirring for 2 hours to obtain a homogeneous solution. Subsequently, the solution was cooled to room temperature and the film was cast on a substrate (e.g., glass slide or metal sheets) using a film scraper (KTQ-II) or a coating rod. The prepared coatings were left in ambient air at room temperature until the hexane completely evaporated. The concentration and ratio of EPC and caprylyl methicone were adjusted to achieve an optimal condition.

2.3 Characterization

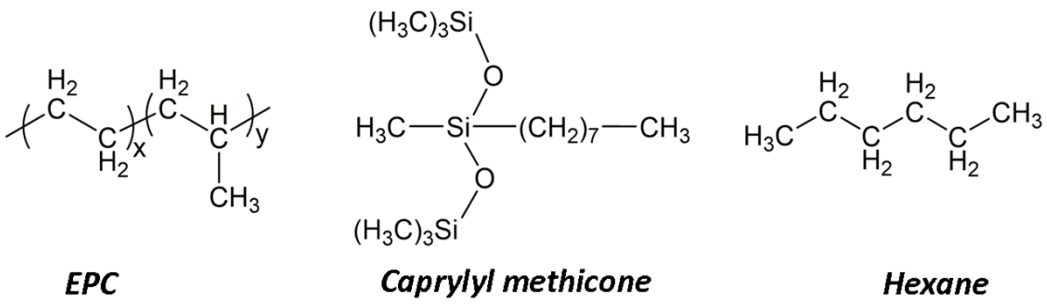
Surface morphologies of the coating with different EPC compositions were observed using a field emission environmental scanning electron microscope (FE-SEM, Quanta 400F) after rinsing the coating with ethanol to remove caprylyl methicone. The coating becomes opaque after removing caprylyl methicone because the difference in refractive indices between air and polymer becomes larger. The temperature of homogeneous solutions for eSLIPS systems was measured using a thermocouple (Digital Thermometers, UT325). The pore size and porosity distribution of the SLIPS coating were determined by analyzing the SEM images with *Image J* software. The phase separation process was observed using optical microscopy (DM2700p, LEICA). Water contact angles (WCAs) and sliding angles (SAs) were measured using a contact angle measurement system (OCA 15EC, Dataphysics). The volume of water drops for WCA testing was 2 μL and 10 μL for SA testing. The SA was measured using a micrometer precision stage (DPIG-60R84).

2.4 Anti-icing experiment

The recirculating cooling system consists of a cryostat reaction bath (Hangzhou Genyu, DHJF-4002) and a home-made ice chamber. The eSLIPS coating was affixed to the cold stages of the ice chamber, and the temperature was maintained at -10 to -25 °C. The ice adhesion was tested using a mechanical test system (Shence, SC-50N) and the freezing delay time was recorded by a high-speed camera (Huarui, A5131MU210). To measure the ice adhesion strength, 1 mL of pure water was injected into a cubic mold (with a section of 10 mm × 10 mm) placed on the sample surface and frozen at -20 °C for 2 hours. The de-icing force was measured by a force gauge fixed on a linear motion stage, which moved at a constant speed of 1 $mm \cdot s^{-1}$ to pull the mold until the maximum force was reached. The ice adhesion strength was calculated as $\tau = F/A$, where F was the peak value of thrust and A was the contact area of the ice column. Additionally, the samples were affixed to the cooling stage, pre-frozen for 10 minutes, and then 5 μL of pure water droplets were dropped on the samples. The freezing process was recorded using a high-speed camera. The measurements were conducted three times to obtain error bars.

2.5 Electrochemical experiment

The corrosion resistance of eSLIPS-coated substrate was assessed using electrochemical impedance spectroscopy (EIS) by an electrochemical workstation (Corrtest Instruments) at 25 °C. EIS measurements were performed in the frequency range of 100 kHz to 0.01 Hz with an amplitude of 10 mV. Before EIS measurements, the sample was immersed in the corrosive medium for 15 min to achieve a steady open-circuit potential. In this experiment, a NaCl aqueous solution (3.5 wt%) was selected as the test corrosive medium, and a standard three-electrode cell was used, with a platinum electrode serving as the counter electrode, a saturated calomel electrode as the reference electrode, and the sample as the working electrode. The exposure area of the sample was standardized to 1 cm^2.



Scheme S1 Molecular structure of EPC, caprylyl methicone and hexane

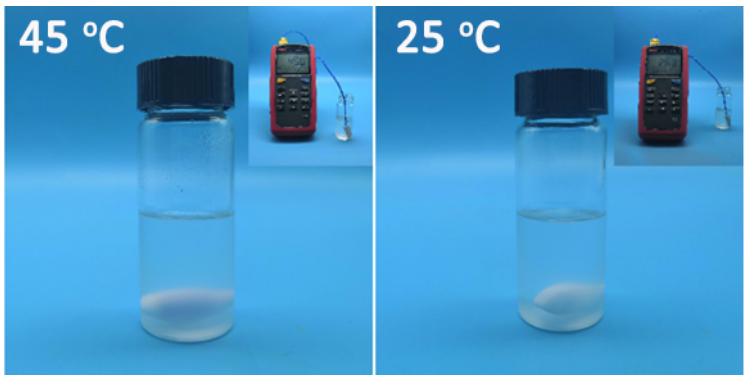


Figure S1. Caprylyl methicone/EPC/hexane ternary solution at dissolution temperature (45 °C) and room temperature (25 °C).

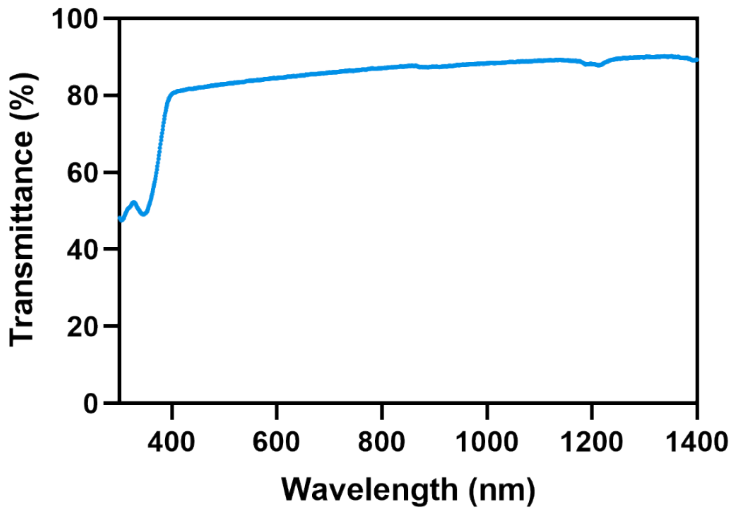


Figure S2. UV-Vis spectra of the eSLIPS coating with a thickness of ~200 µm

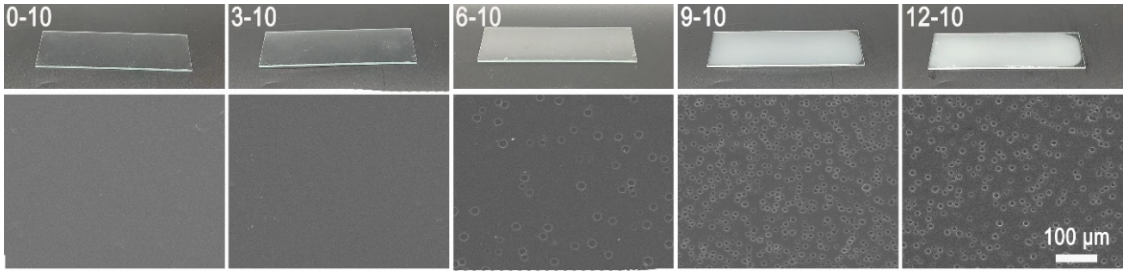


Figure S3. Digital pictures and SEM images of coatings fabricated under different caprylyl methicone/EPC concentration ratio for 0-10 to 12-10. The concentration of EPC is fixed at 10 wt%

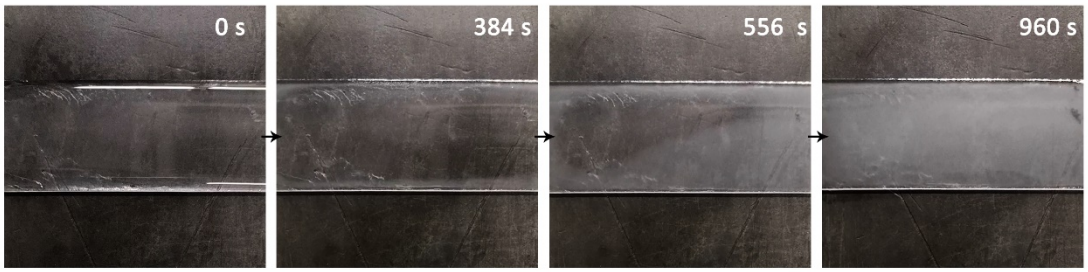


Figure S4. Digital pictures of phase separation process on a glass substrate during solvent evaporation. Caprylyl methicone:EPC=10 wt%:10 wt%.

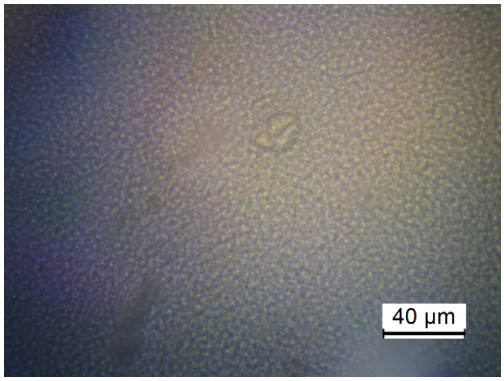


Figure S5. Microscopic image of the eSLIPS, 24 hours after fabrication. Caprylyl methicone:EPC=10 wt%:10 wt%.

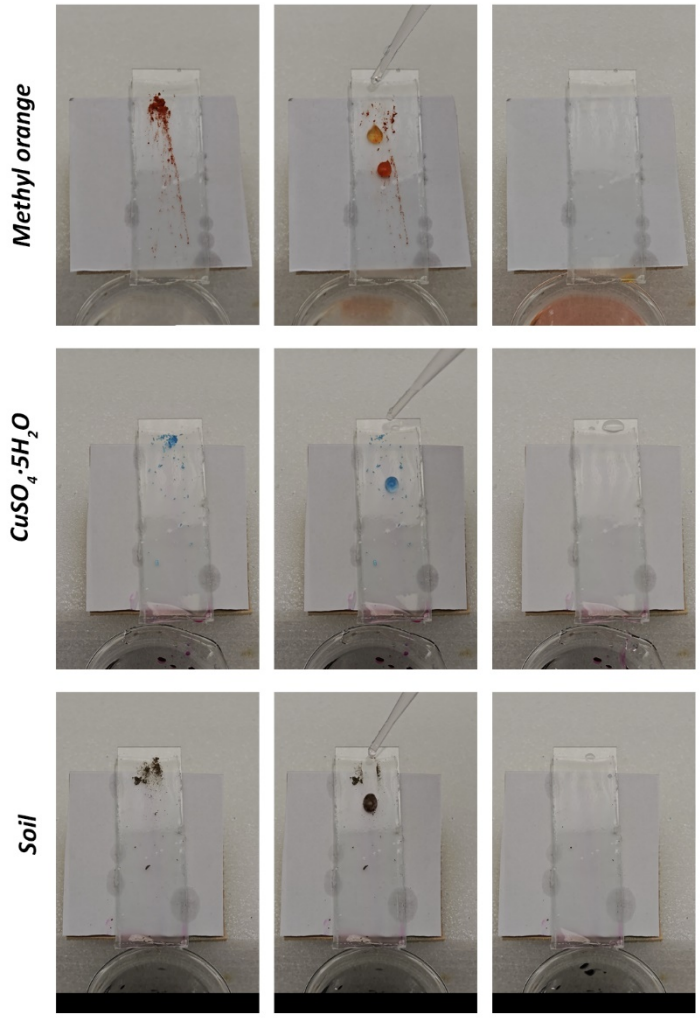


Figure S6. Demonstrative experiment of self-cleaning properties of eSLIPSs.

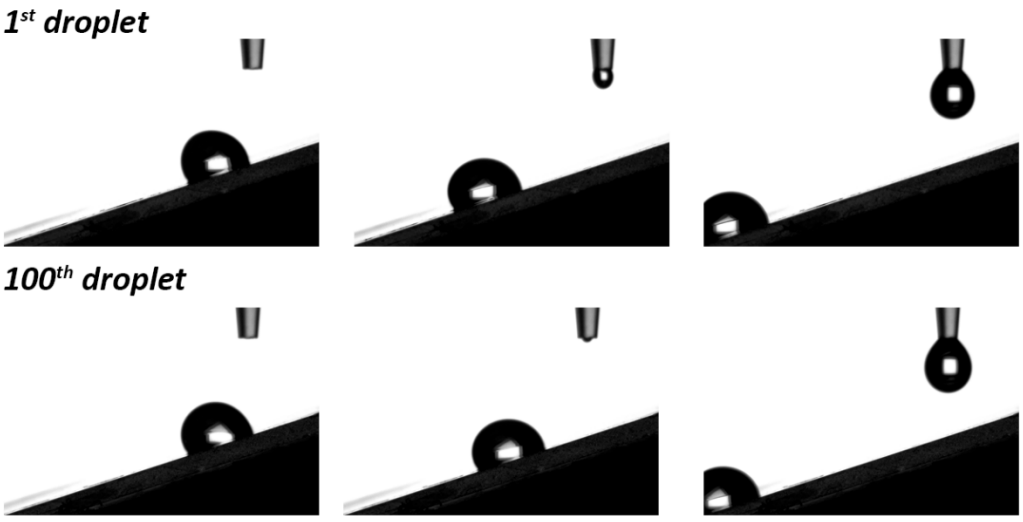


Figure S7. Multi-cycle sliding experiment on eSLIPSs. 100 droplets were dropped on

the same position

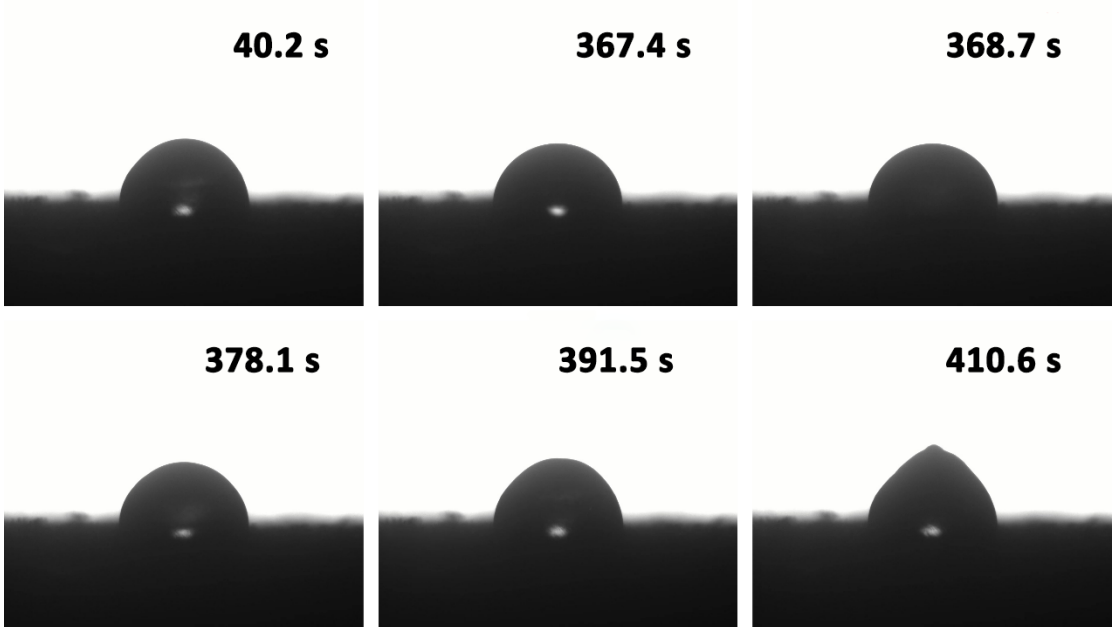


Figure S8. Delayed icing process on the eSLIPS with a caprylyl methicone/EPC ratio of 10 wt%:10 wt% under -20 °C.

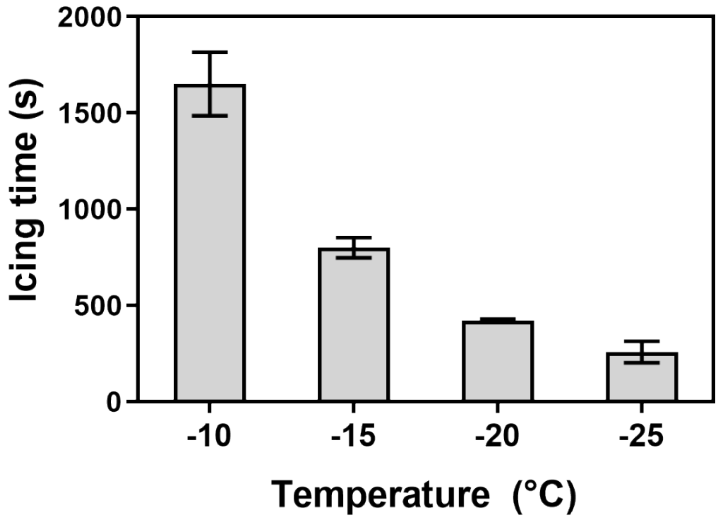


Figure S9. Icing time under different temperatures on the eSLIPS with a caprylyl methicone/EPC ratio of 10 wt%:10 wt%.

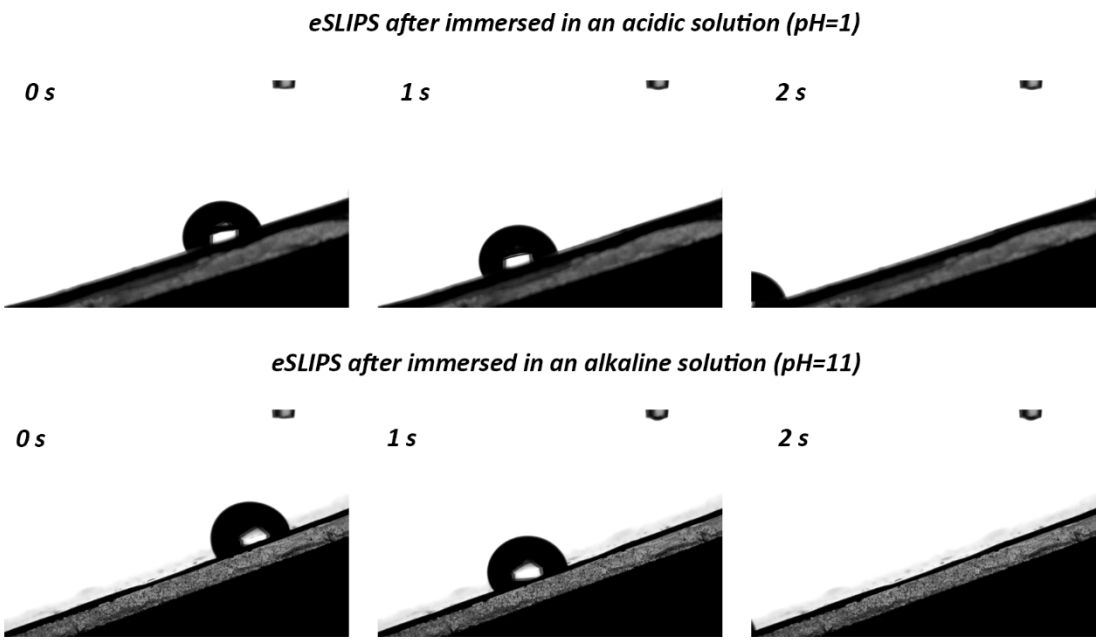


Figure S10. Sliding experiment of eSLIPS after immersed in acidic (pH=1) and alkaline (pH=11) solutions for 24 hrs.

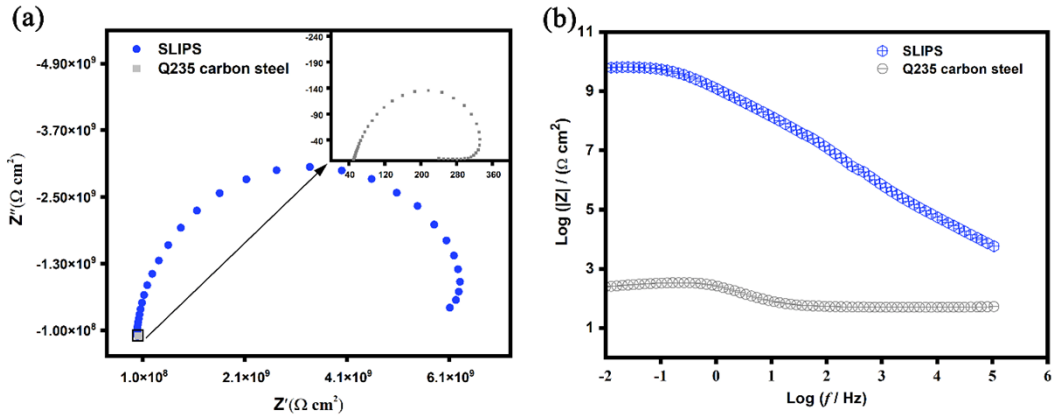


Figure S11. a) Nyquist plots and b) Bode plotes of SLIPS and Q235 carbon steel tested with 3.5 wt % NaCl aqueous solution as corrosive medium. Caprylyl methicone:EPC=10 wt%:10 wt%.