Electronic Supplementary Material

Ultralow friction polymer composites incorporated with mono-dispersed oil microcapsules

Lin ZHANG[1], Guoxin XIE[1,*], Shuai WU[1], Shiguang PENG[1], Xiaoqing ZHANG[2], Dan GUO[1], Shizhu WEN[1], Jianbin LUO[1,*]

[1] *State Key Laboratory of Tribology, Department of Mechanical Engineering, Tsinghua University, Beijing 100084, China*

[2] *School of Materials Science and Mechanical Engineering, Beijing Technology and Business University, Beijing 100048, China*

Supporting information to https://doi.org/10.1007/s40544-019-0312-4

1 Materials preparation

A series of microcapsules composed of different core and wall materials (Polystyrene (PS)/linseed oil, PS/wax, Polysulfone (PSF)/octanol, PS/octanol, and PS/simethicone) were prepared by the solvent evaporation method referred in the main text. The synthesized PS/wax microcapsules were incorporated into the epoxy matrix for evaluating the lubrication properties of the composite. 0.7 g PS/wax microcapsules were added into 4.5 g EP liquid under stirring at room temperature for 20 min to form a good suspension. Then, 1.5 g curing agent was added into the solution under stirring for 10 min and poured into a rubber mold after removing the bubbles in a vacuum drying oven. The specimen was cured at room temperature for 24 h, producing an epoxy-based composite with 10 wt.% microcapsules.

2 Characterization

Scanning electron microscopy (SEM, HITACHI UHR FE-SEM SU8220) was used to determine the morphologies of the samples. The friction tests of the EP resin with PS/wax microcapsules were carried out with a universal ball-on-disk microtribometer (UMT-3, CETR, USA). GCr15 bearing steel balls of Φ4.6 mm in diameter were used as the counterface. The friction tests were carried out at a reciprocating speed of 32 mm/s under 3 N for 20 min.

3 Results and discussion

As shown in Fig. S1, all the prepared microcapsules were monodipersed and with a diameter range of 1–5 um. The shell structure shown in Fig. S1(b) further confirmed the successful preparation of microcapsules. All the surfaces of the microcapsules were smooth and compact without obvious defects and holes, which could effectively improving the stability of microcapsules. It is noteworthy that the diameter and the size distribution of various microcapsules synthesized under the same experimental conditions were quite different, implying that

* Corresponding authors: Guoxin XIE; E-mail: xgx2014@tsinghua.edu.cn; Jianbin LUO, E-mail: luojb@tsinghua.edu.cn

the properties of the core and the shell materials, such as viscosity and the compatibility with the solvents play important roles in the synthesis process of microcapsules.

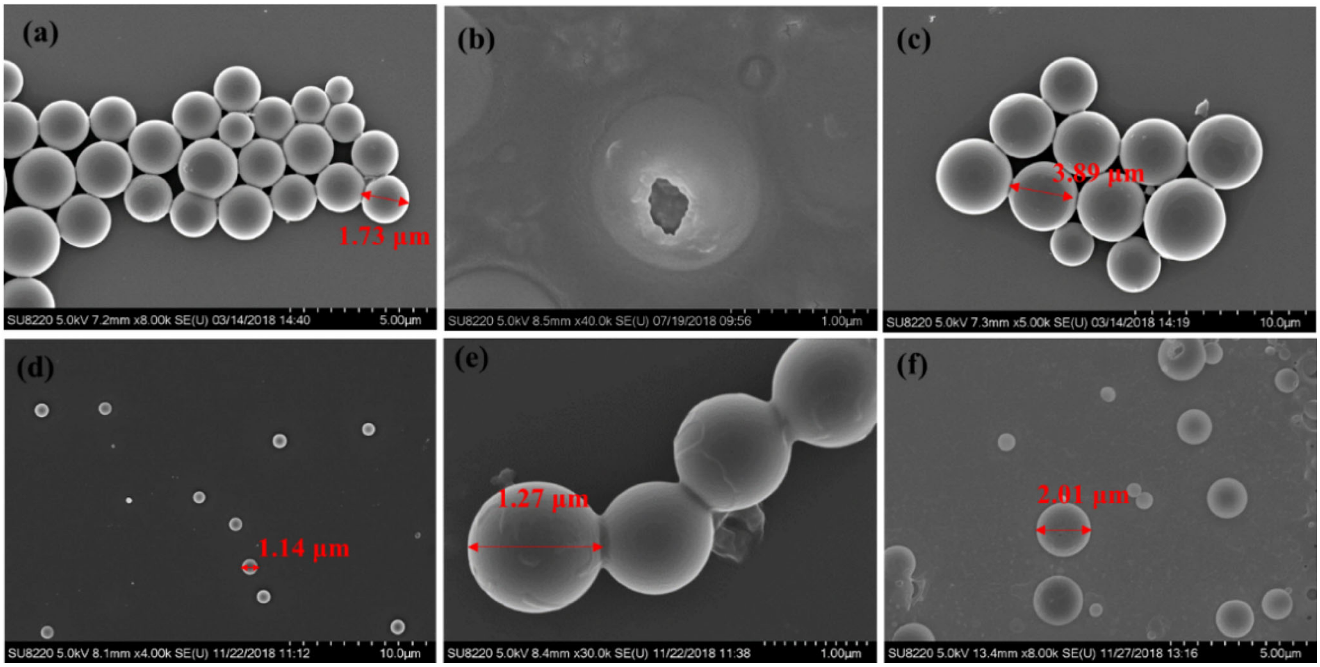

Fig. S1 SEM images of (a) PS/octanol microcapsules, (b) ruptured PS/octanol microcapsule, (c) PSF/octanol microcapsules, (d) PS/linseed oil microcapsules, (e) PS/simethicone microcapsules, and (f) PS/wax microcapsules.

The lubrication properties of the EP resin and the composite with 10 wt.% PS/wax microcapsules were investigated at a sliding speed of 32 mm/s under 6 N. As shown in Fig. S2, the lubrication performance of the composite was greatly improved after the incorporation of microcapsules, and the friction coefficient drastically decreased from 0.61 to 0.07. For comparison, the lubrication properties of the wax were carried out under the external lubrication condition where the wax was directly added into the interface between the EP resin surface and the ball surface. As shown in Fig. S2, the friction coefficient of the EP resin decreased to 0.06 after adding 2 μL wax into the interface, presenting an excellent lubrication performance. The above results indicate that the composites with microcapsules could achieve comparable lubrication properties to the case under external lubrication.

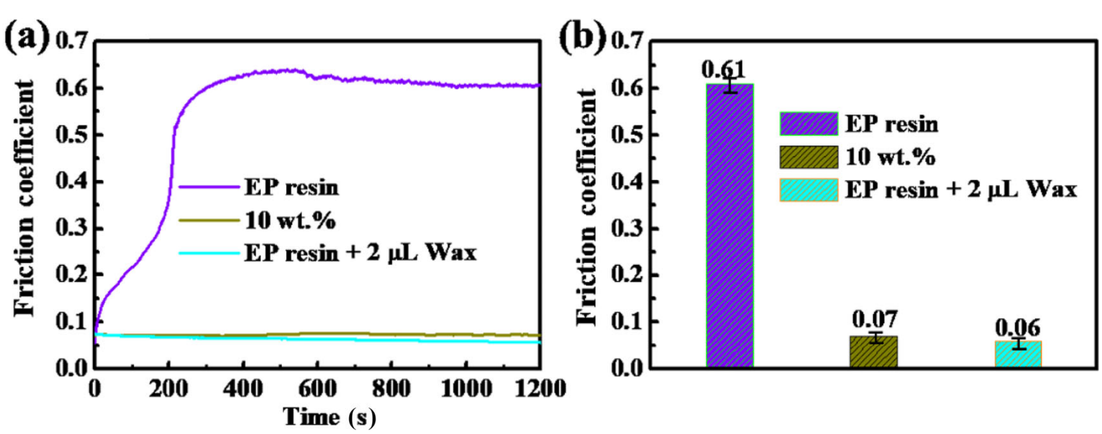

Fig. S2 Friction coefficient of samples at a sliding speed of 32 mm/s under 6 N.