

## Supplementary Materials for

# **Mucus-inspired solvent-free carbon dot-based nanofluid triggers significantly tribological synergy for sulfonated h-BN reinforced epoxy composites**

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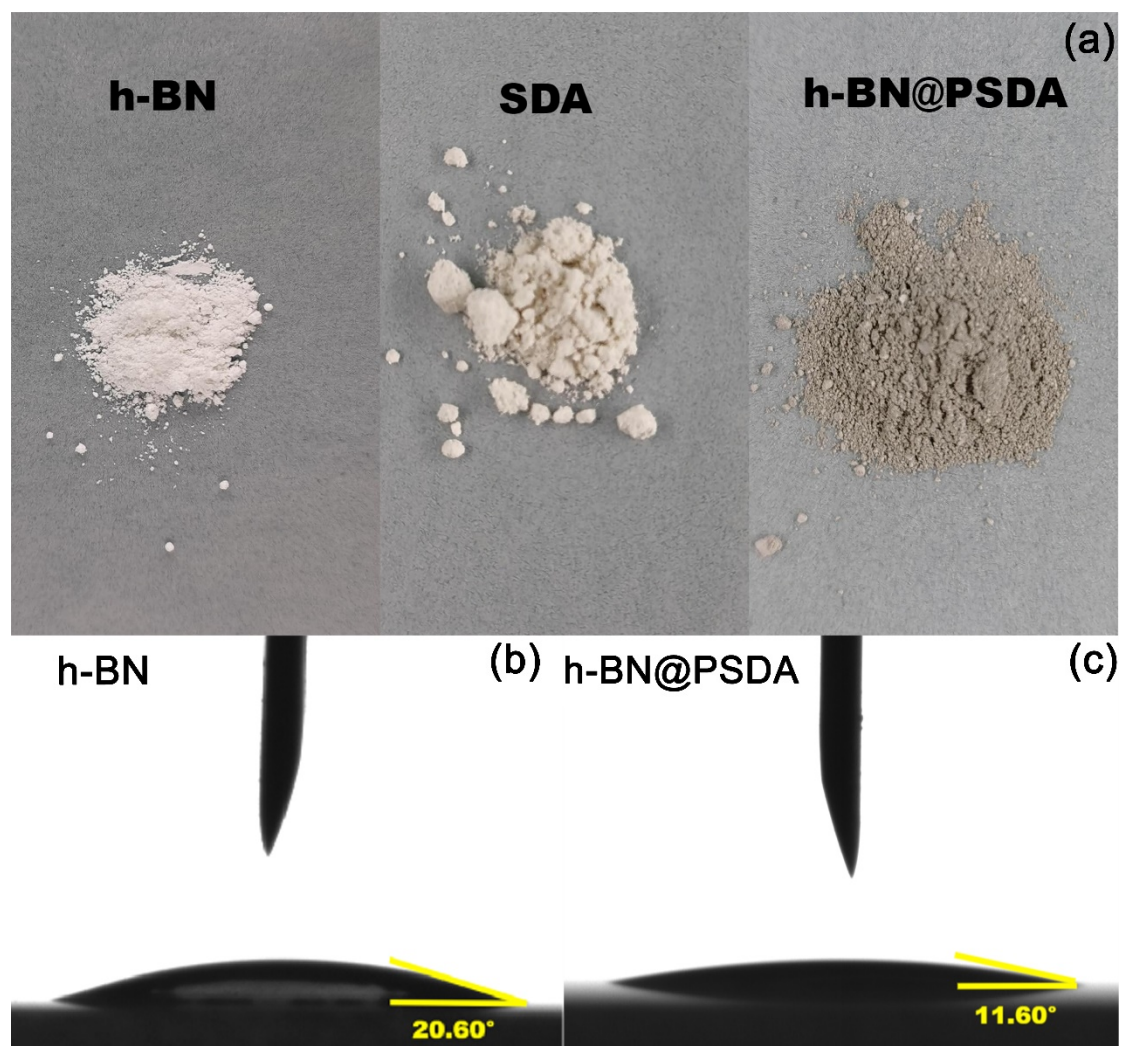
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### **Fabrication of EPs composites**

5 g of epoxy resin (EPs) and 1.5 g of the curing agent are mixed well with a blender, the resulted mixture was poured into a Teflon mold and put into a vacuum drying oven for degassed at room temperature to degas until no air bubbles were generated. The h-BN/EPs composites were obtained by curing at 60 °C for 12 h, 80 °C for 3 h, 120 °C for 2 h in atmospheric pressure oven.

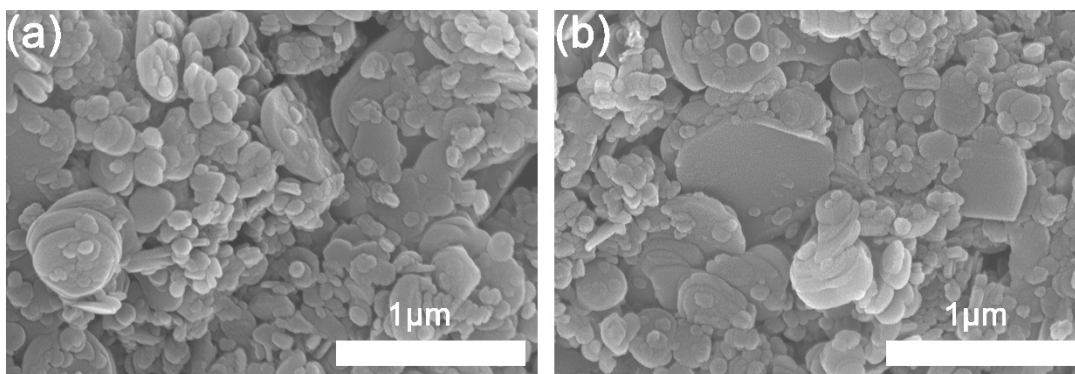
### **Fabrication of h-BN/EPs composites**

0.03 g of h-BN was added to dispersed in acetone solution and under ultrasonically dispersed well sonication, and then 5 g of epoxy resin (EPs) was added. The mixture was firstly mixed well with a blender. The major part of the solvent (acetone) was removed via evaporation in air under followed by removing part of the solvent using magnetic stirring, and after partial evaporation of acetone, the remaining solvent was continued to be removed and the residue was removed in a vacuum oven. After removing the solvent removal, 1.5 g of the curing agent was added to blended to the mixture and mixed well in using the a speedmixer (DAC150.1 FVZ-K, Germany). Finally, the resulted mixture was poured into the Teflon mold and put into a vacuum drying oven for degassed at room temperature to degas until no air bubbles were generated. The h-BN/EPs composites were obtained by curing at 60 °C for 12 h, 80 °C for 3 h, 120 °C for 2 h in atmospheric pressure oven.



**Figure S1.** (a) sample drawings of h-BN, SDA and h-BN@PSDA. (b) contact angle measurements for h-BN. (c) contact angle measurements for h-BN@PSDA.

The morphology of the h-BN changes obviously before and after chemical modification, and the color changes from white to grey, *c.f.* Fig. S1 (a). The contact angles of the aqueous dispersion of h-BN decrease from 20.6° to 11.6° after PSDA modification due to the existence of hydroxyl hydrophilic groups and sulfonic hydrophilic groups in the PSDA.

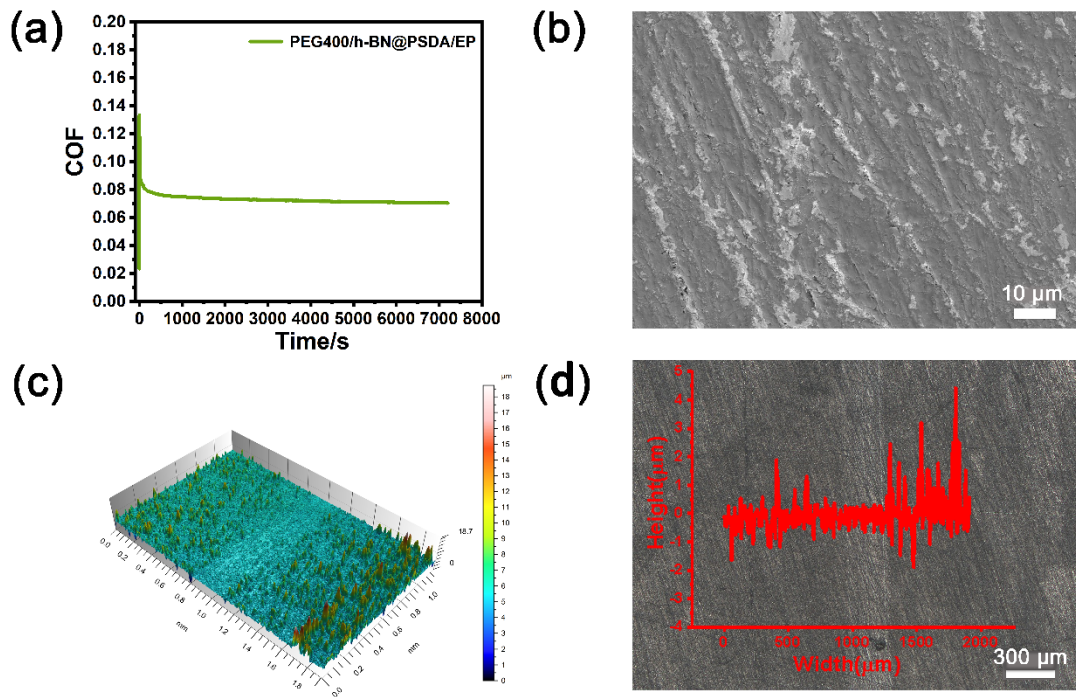


**Figure S2.** SEM images of (a) h-BN and (b) h-BN@PSDA, respectively.

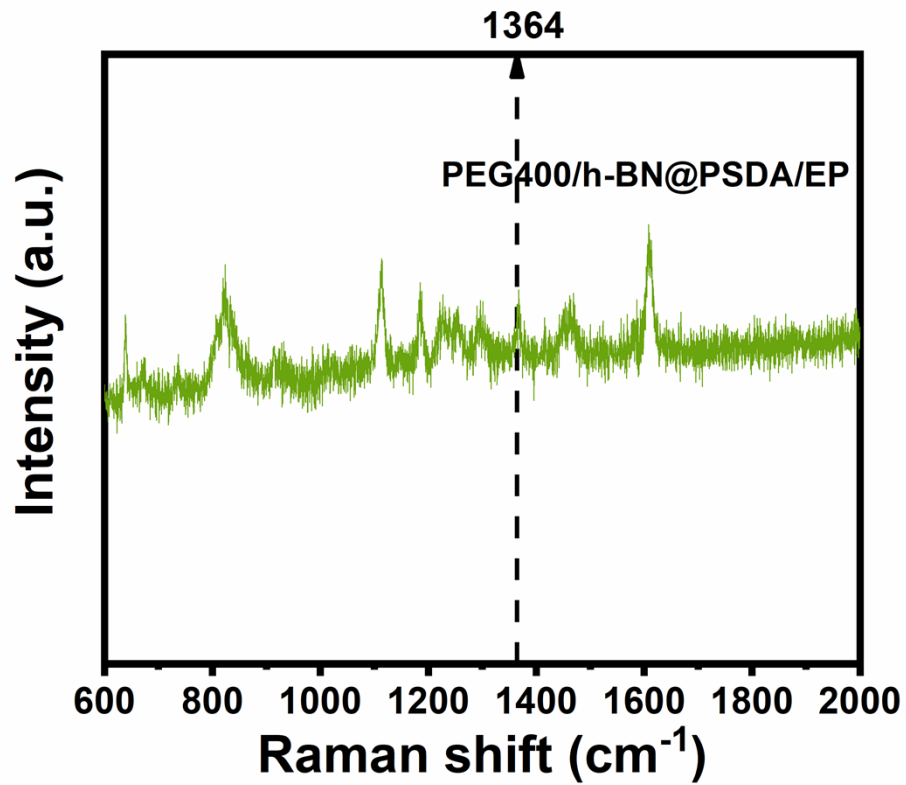
Fig. S2 (a) and (b) show the SEM images of h-BN before and after PSDA modification, the pristine h-BN nanosheets show disc-like shapes with clear edges and smooth surfaces of uneven dimensions. The shape of h-BN did not change obviously after PSDA modification.

The specific heat capacity ( $C_p$ ), density ( $\rho$ ), and thermal diffusion ( $\alpha$ ) of the three groups of epoxy resin composites are shown in the table S1.

	$C_p(\text{J}/(\text{g}\cdot^\circ\text{C}))$	$\rho(\text{g}/\text{cm}^3)$	$\alpha(\text{mm}^2/\text{s})$
<b>EP</b>	<b>1.15</b>	<b>1.148</b>	<b>0.135</b>
<b>h-BN/EP</b>	<b>1.12</b>	<b>1.166</b>	<b>0.142</b>
<b>h-BN@PSDA/EP</b>	<b>1.13</b>	<b>1.167</b>	<b>0.147</b>

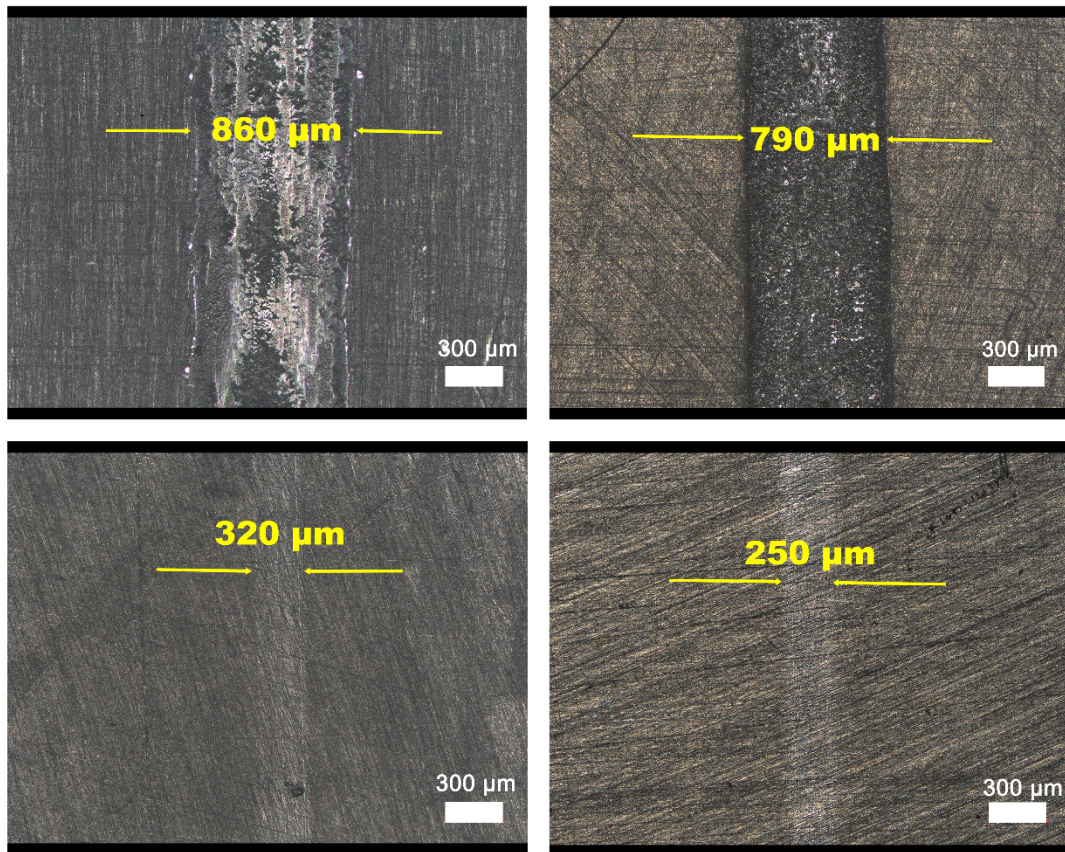


**Figure S3.** (a) Friction coefficient for long time friction test of PEG 400/h-BN@PSDA/EPs composites. (b) SEM image of the PEG 400/h-BN@PSDA/EPs composites at the abrasion marks. 3D topographies (c) and corresponding cross-sectional profiles (d) of wear tracks on the worn surface gained by PEG 400/h-BN@PSDA/EPs composites.



**Figure S4.** shows the Raman spectra of the wear traces of h-BN@PSDA/EPs lubricated with PEG 400.

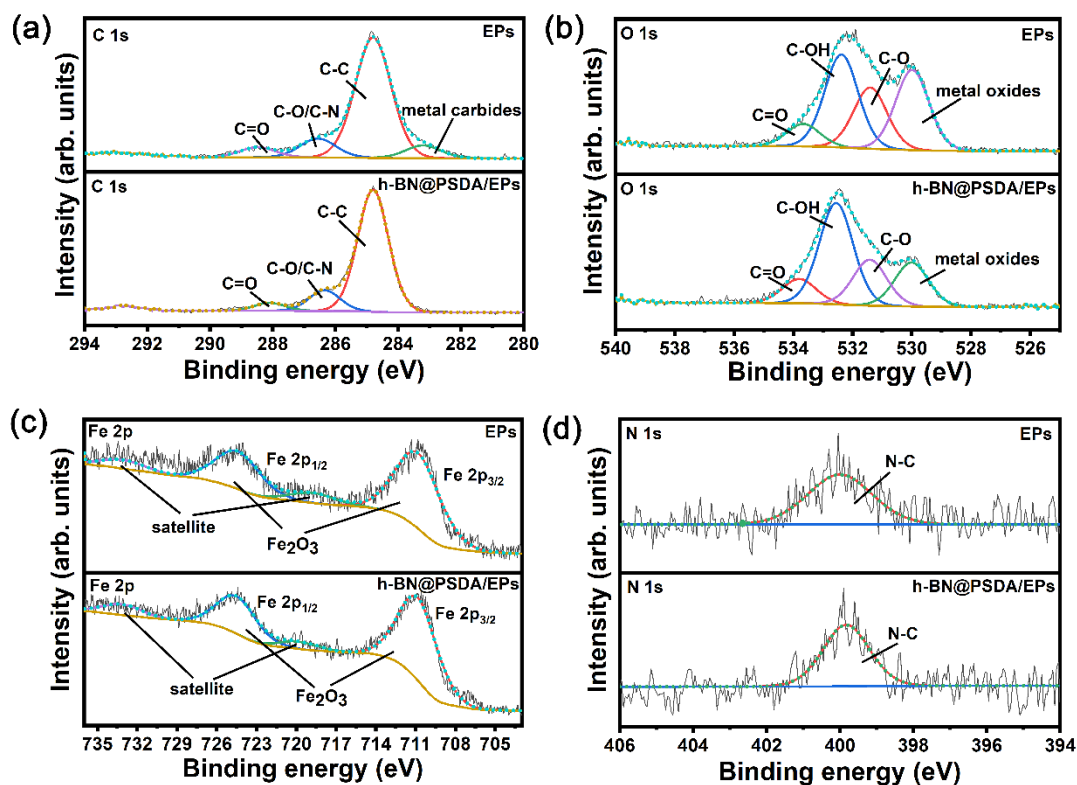
In addition to the characteristic peak of epoxy resin, the characteristic peak of h-BN is observed at 1364 cm<sup>-1</sup> at the wear trace of the h-BN@PSDA/EPs lubricated with PEG 400.



**Figure S5.** Confocal Microscopy of abrasion marks on surfaces of EPs (a), h-BN@PSDA/EPs (b), PEG 400/h-BN@PSDA/EPs (c) and F-CDs/h-BN@PSDA/EPs (d) composites.

The wear widths of EPs, h-BN@PSDA/EPs, PEG 400/h-BN@PSDA/EPs and F-CDs/h-BN@PSDA/EPs are 0.86, 0.79, 0.32 and 0.25 mm, respectively (Fig. S5). This indicates that h-BN and F-CDs play a positive role in reducing the wear of EPs.





**Figure S6.** XPS spectra of C 1s (a), O 1s (b), Fe 2p(c), N 1s(d) of the counter steel surfaces sliding against EPs and h-BN@PSDA/EPs under dry conditions.

Fig. S6 shows the XPS elemental spectra of O 1s, C 1s Fe 2p, N 1s for the worn steel surfaces sliding against neat EPs and h-BN@PSDA/EPs, respectively. The XPS fine spectra of Fe 2p for neat EPs and h-BN@PSDA/EPs indicate that the main Fe species present on the worn surface are  $\text{Fe}_2\text{O}_3$ . XPS fine spectra for N 1s of neat EPs and h-BN@PSDA/EPs show that organic nitrogen compounds form a self-lubricating film on the worn surface. Compared to the pure epoxy resin, the h-BN@PSDA/EPs composite corresponds to almost the same position of the binding energy for c1s and o1s. The difference is that the pure epoxy resin has a characteristic peak of metal carbide at 283.2

eV in the fine spectrum of C 1s, which may be attributed to the tribochemical reaction between the epoxy matrix and the steel ball.