Supporting Information

1. Detailed preparation process of unmodified silica nanoparticles

Unmodified silica nanoparticles (USNs) were prepared using stöber method. The tetraethyl orthosilicate (TEOS) was added into the mixture of ethanol, water and aqueous ammonia and the resulted mixture was gently stirred at 300 rpm, temperature of 40 ℃. For 100 nm silica nanoparticles, the mixture of ethanol, water and aqueous ammonia was prepared by adding 2 wt% of water and 5 wt% of aqueous ammonia into ethanol. After the mixture was heated to 40 ℃, 5 wt% TEOS was first diluted to added into it by one time. After 3 hours, the solution became slightly turbid and blue, which indicated the formation of 100 nm USNs.

2. XRD pattern for USNs and HSNs

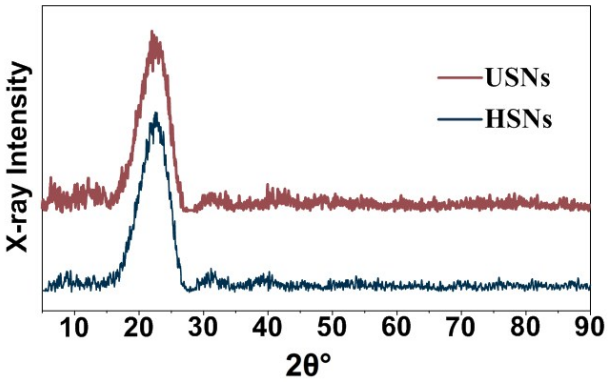

Fig S1. The XRD pattern for USNs and HSNs

3. Brunauer-Emmett Teller (BET) method Test result

Slope=12.621,
Correlation coefficient, r=0.999833,
C constant=57.398
Surface Area=271.125

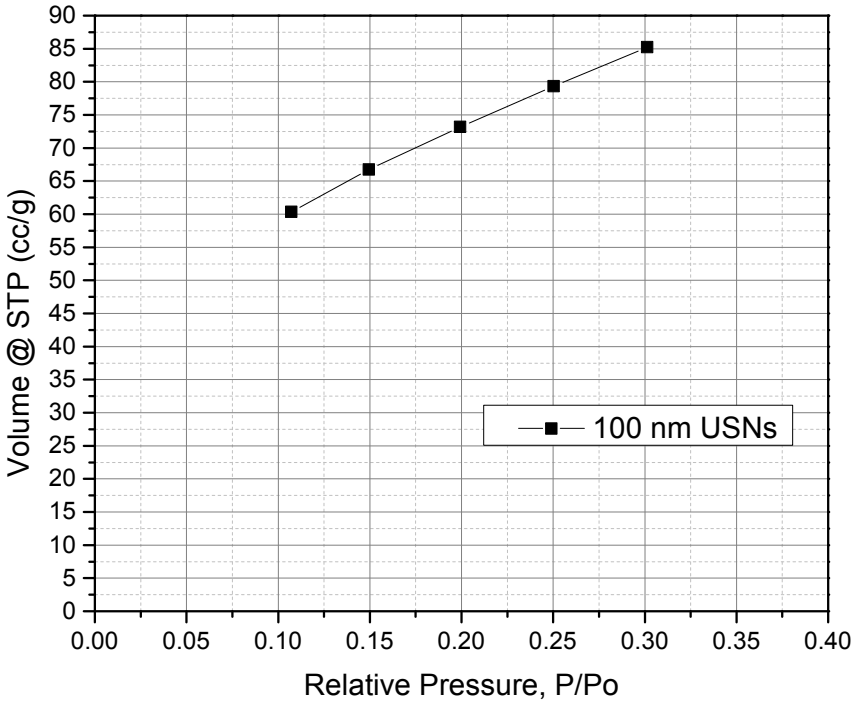

Fig. S2 BET test result for 100 nm unmodified silica nanoparticles

4. Zeta potential of HSNs dispersing in ethanol

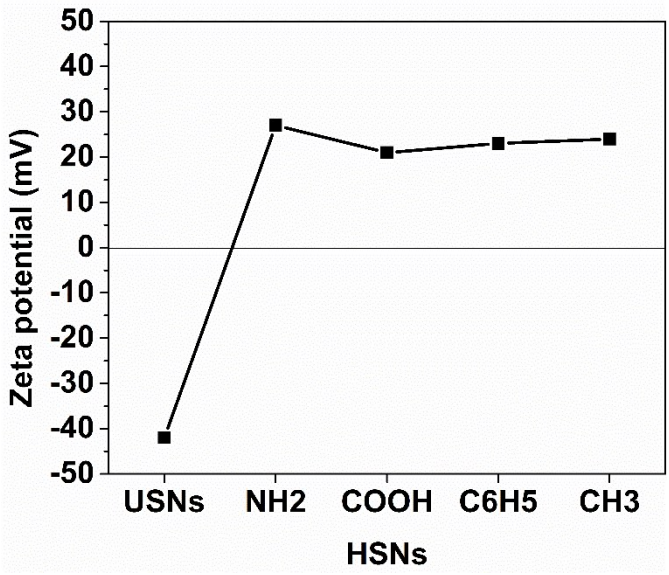

Fig. S3 Zeta potential of HSNs dispersing in ethanol

5. Rheology properties of HSNs-PAO lubricants

The viscosity index (VI) is a important measure for the change of viscosity with temperature. The high the VI, the smaller the change of viscosity with temperature. The VI was calculated as following:

$$V = 100\frac{(L-U)}{(L-H)}$$

V indicates the viscosity index, U the oil's kinematic viscosity at 40 °C (104 °F), and L & H are values

based on the oil's kinematic viscosity at 100 °C (212 °F). L and H are the values of viscosity at 40 °C for oils of VI 0 and 100 respectively, having the same viscosity at 100 °C as the oil whose VI we are trying to determine. These L and H values can be found in ASTM D2270. The VI of different types of HSNs was shown in Fig. S5(b).

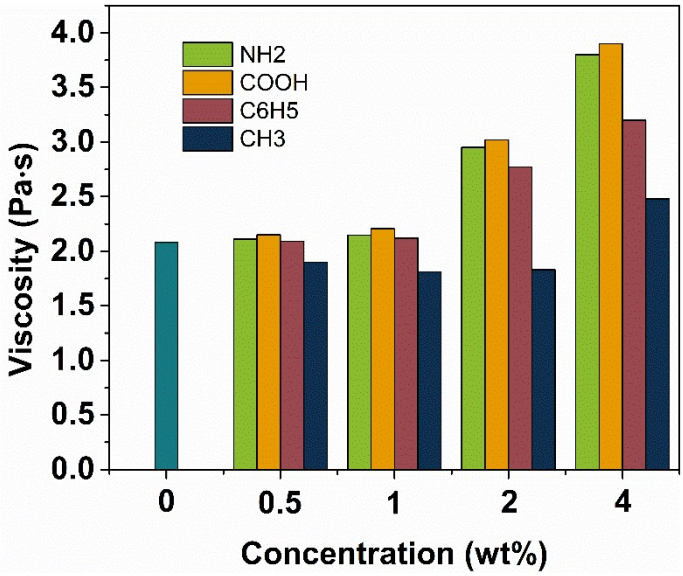

Fig. S4 The viscosity versus concentration for different HSNs.

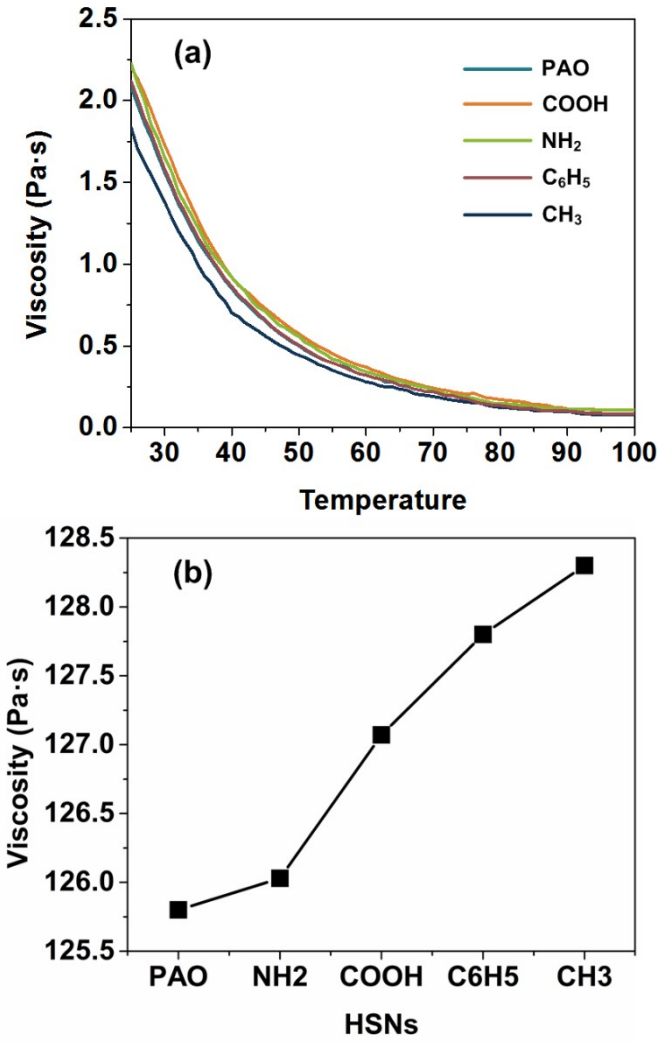

Fig. S5 The viscosity-temperature properties: (a)the viscosity versus temperature of different kinds of HSNs-PAO lubricants, (b) the viscosity index of different kinds of HSNs-PAO lubricants

5. Four-ball test method

Test procedure was list as following:

Place the three test balls in the test-lubricant cup. Place the lock ring over the test balls and screw down the nut securely. Pour the lubricating fluid to be tested over the three test balls until they are covered. Press one ball into the ball chuck and mount the chuck into the chuck-holder Install the test-lubricant cup assembly on the test apparatus in contact with the fourth ball. Place the spacer between cup and thrust bearing. Place the weight tray and sufficient weights on the horizontal arm in the correct notch for a base test load. Release the lever arm and gently apply the test load to the balls, making certain the cup assembly and spacer are centered. If the optional friction-measuring device is used, connect the calibrated arm on the test-lubricant cup to the indicator spring by means of the clip and wire.

The section view of four-ball tribometer was shown in Fig. S3

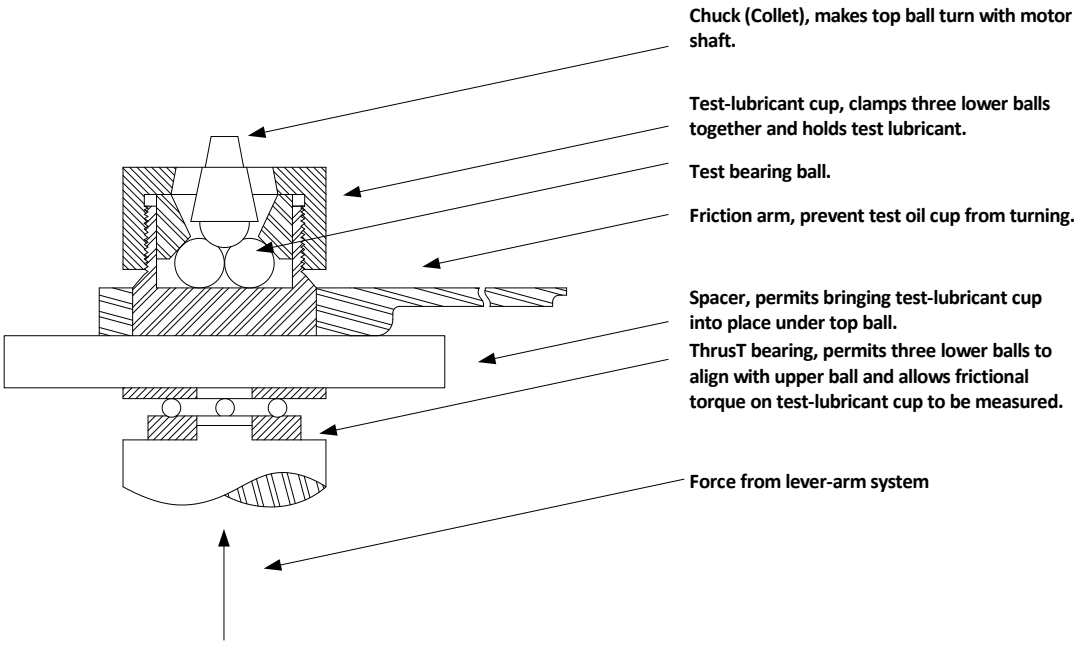

Fig. S6 Section View of Four-Ball Tribometer

6. SEM micrograph of the wear surface using pur PAO lubricant

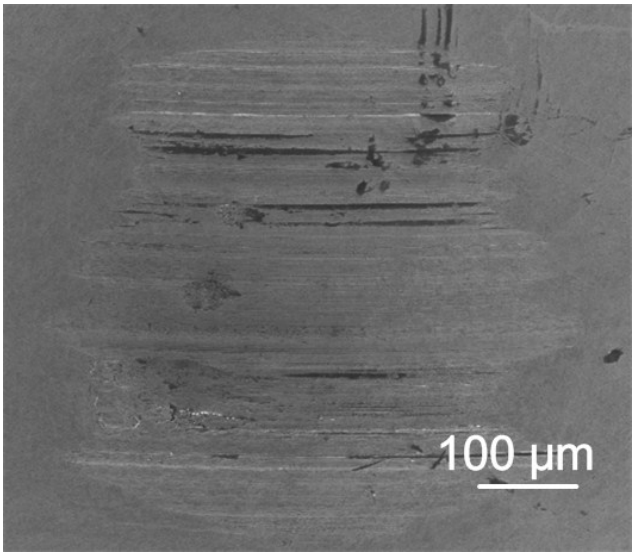

Fig. S7 The SEM micrograph of wear surface for pure PAO