Supplementary Information

Water deteriorates lubricating oils: removal of water in lubricating oils using robust superhydrophobic membrane

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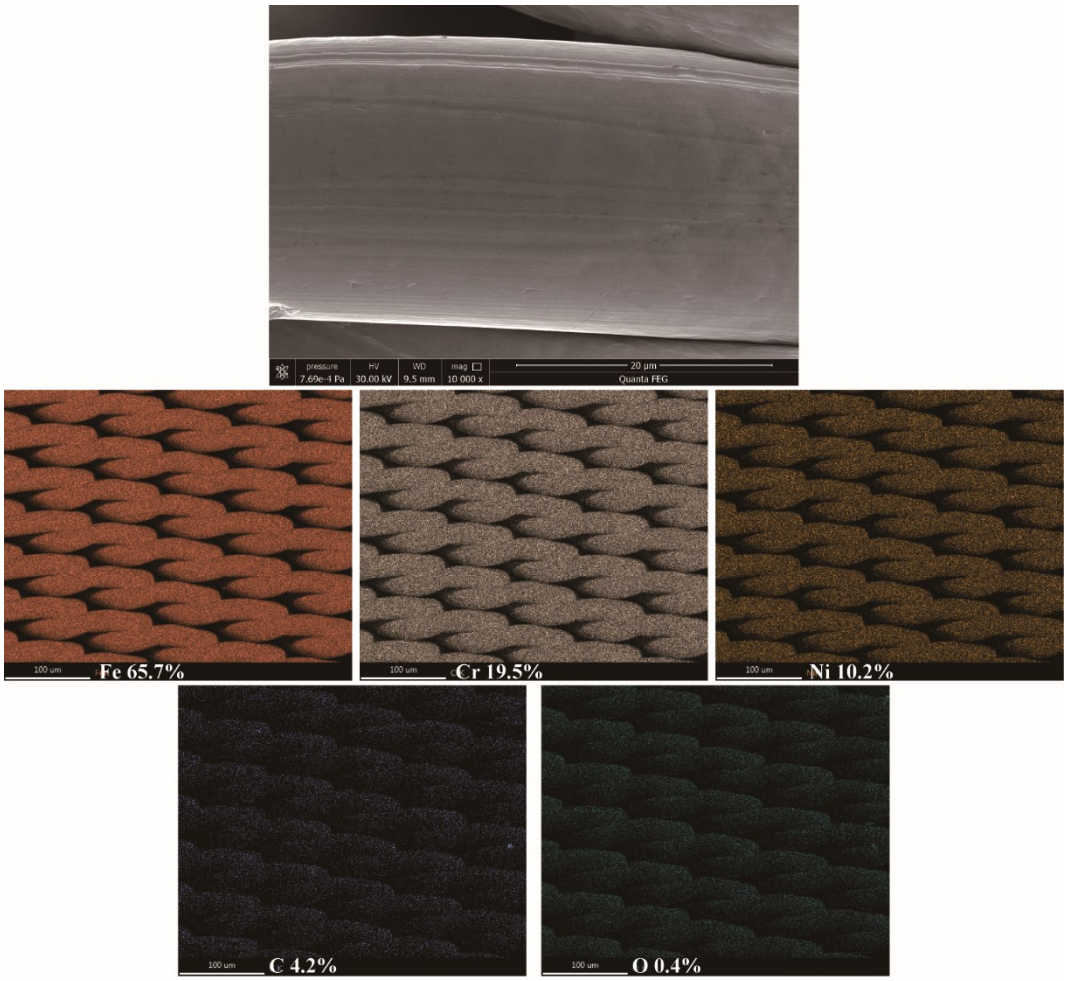

Fig. S1 SEM image, element mapping images, and element weight percentages of original SSM.

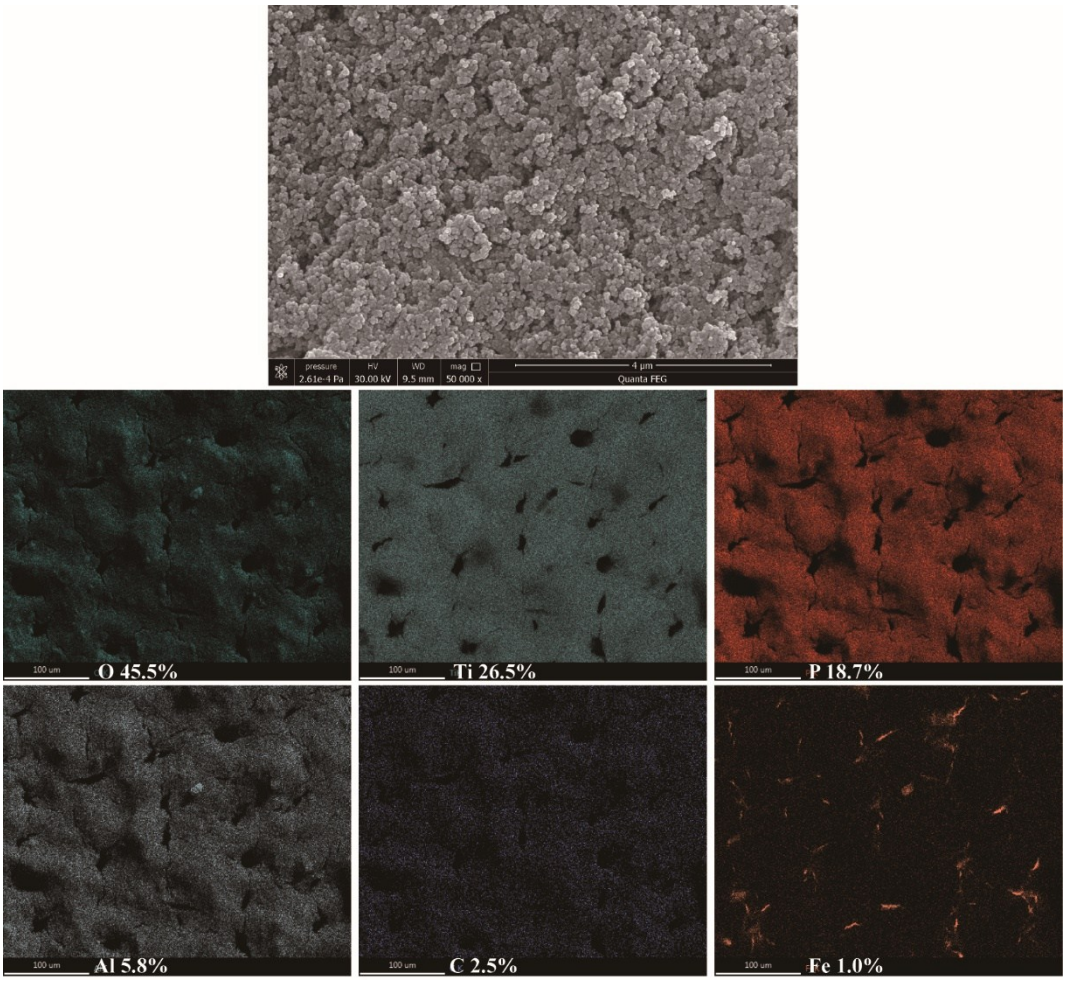

Fig. S2 SEM image, element mapping images, and element weight percentages of AP-TiO_2-coated SSM.

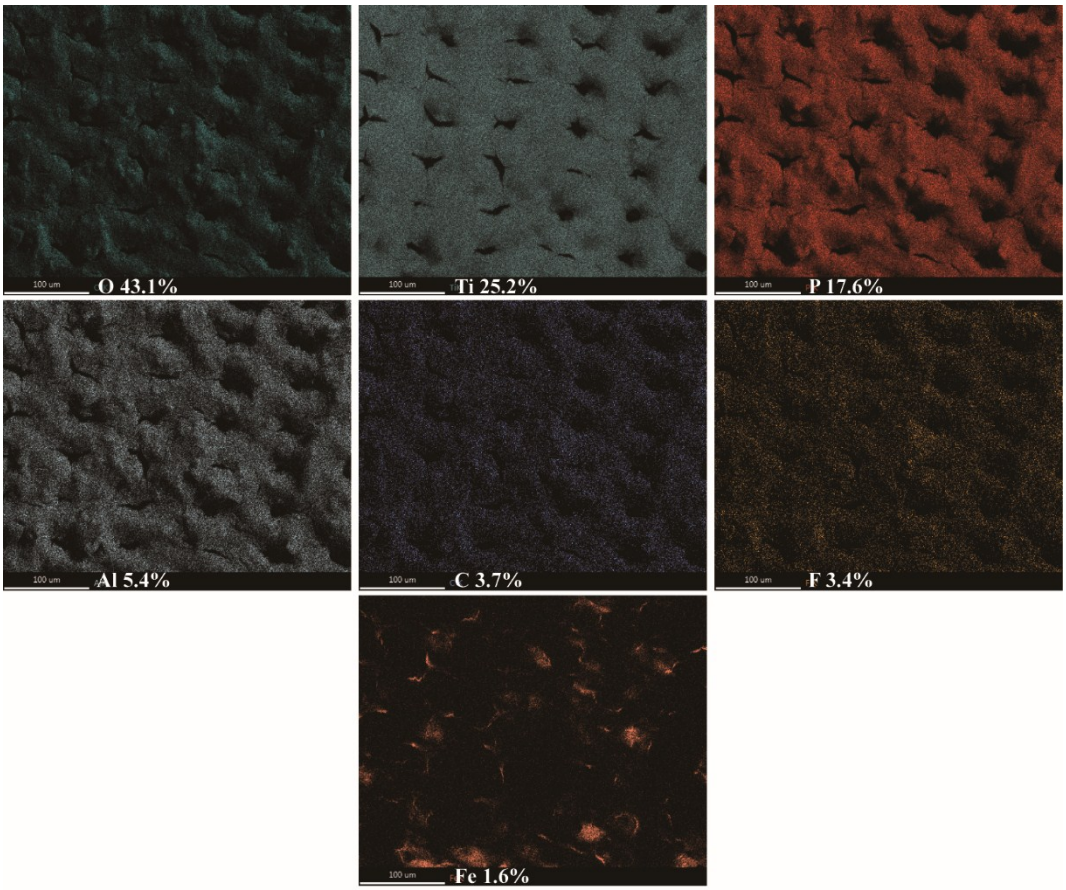

Fig. S3 Element mapping images and element weight percentages of AP-TiO_2-FOTS-coated SSM.

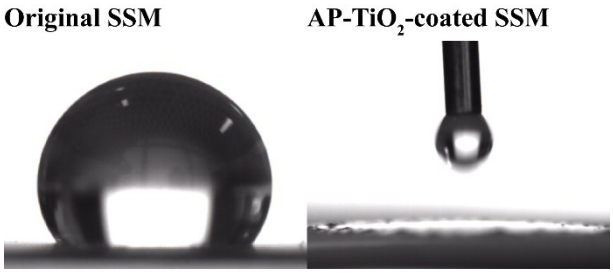

Fig. S4 Photographs of water droplet on the surfaces of original and AP-TiO_2-coated SSMs.

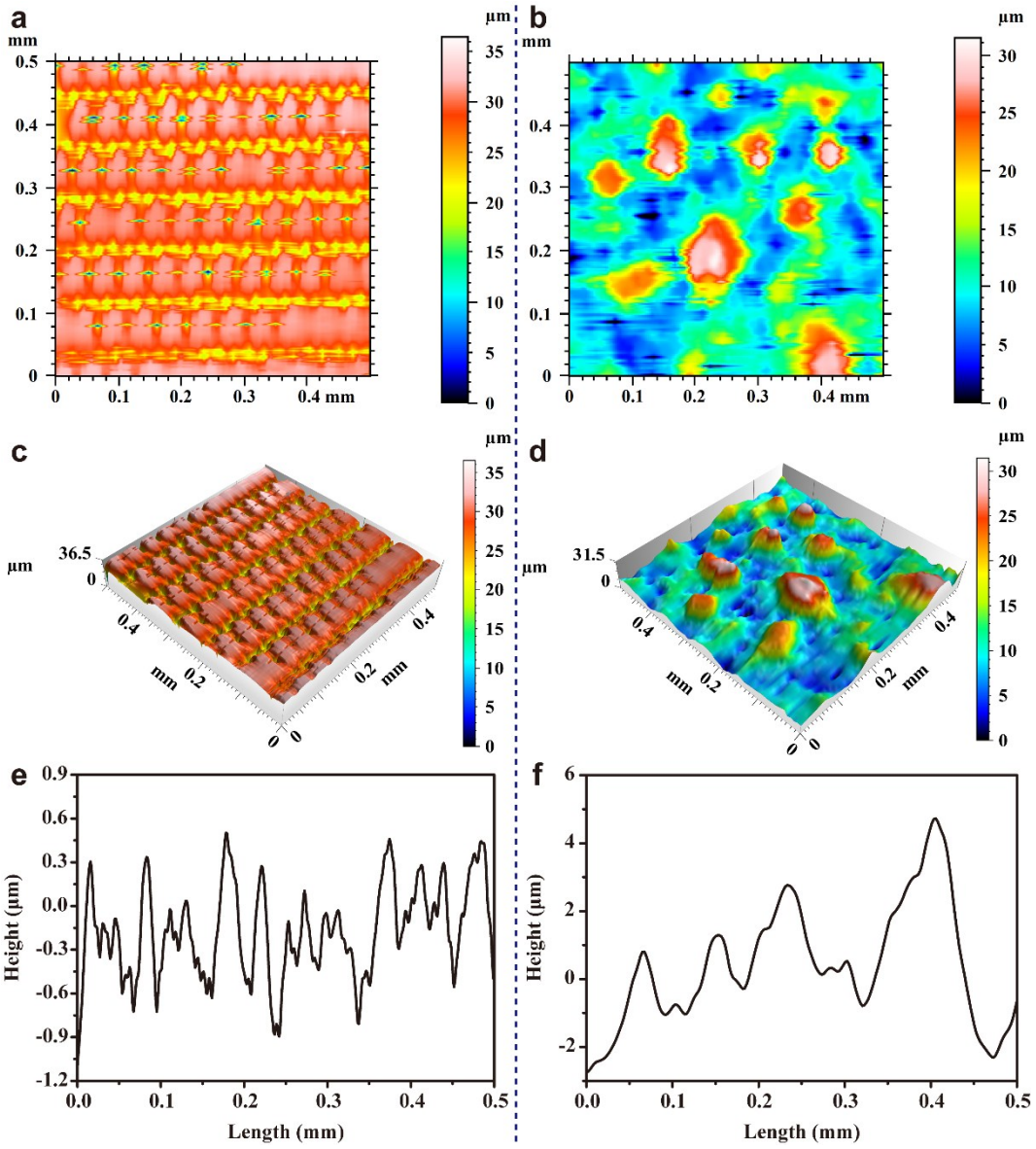

Fig. S5 Surface topographies of original (a, c, e) and AP-TiO_2-FOTS-coated (b, d, f) SSMs. (a, b) Surface 2D plain maps. (c, d) 3D height maps. (e, f) Surface topology profiles.

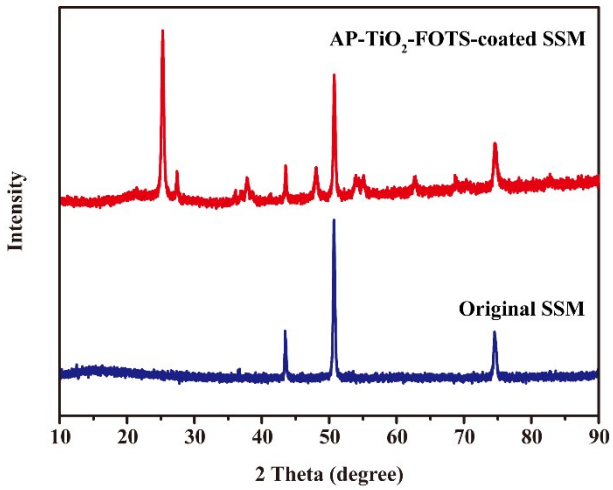

Fig. S6 XRD patterns of original and AP-TiO_2-FOTS-coated SSMs.

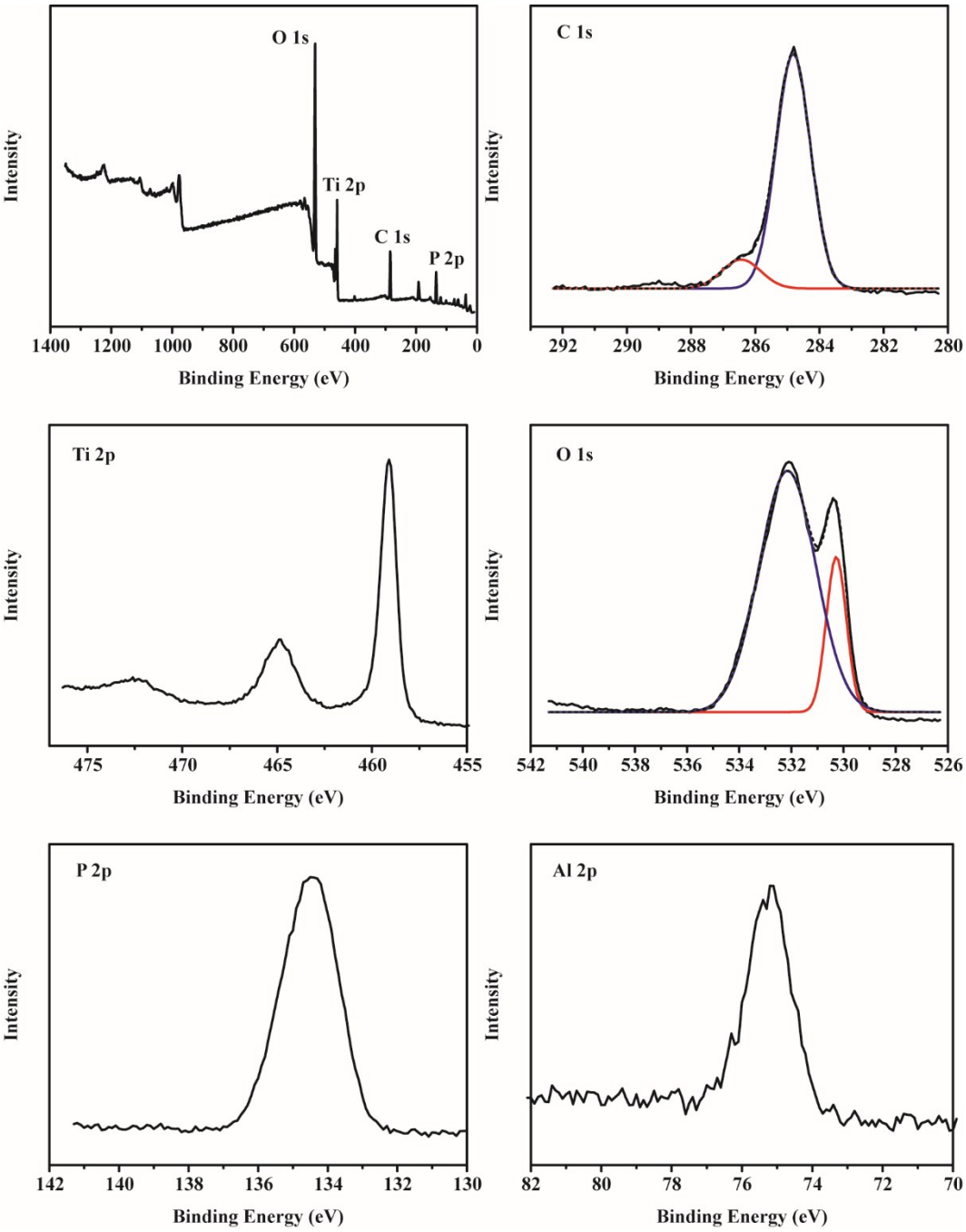

Fig. S7 XPS spectra of AP-TiO_2-coated SSM.

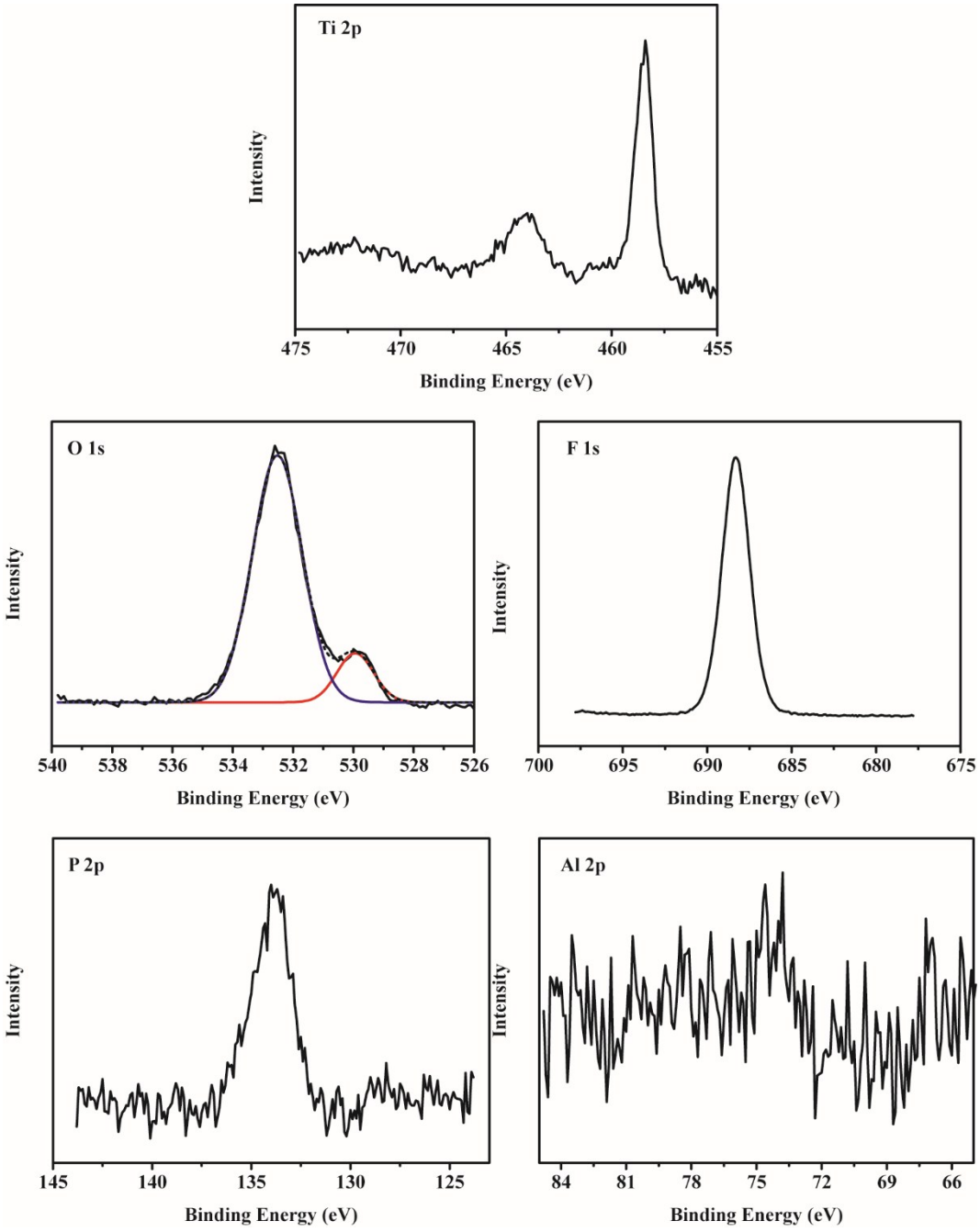

Fig. S8 XPS spectra of AP-TiO_2-FOTS-coated SSM.

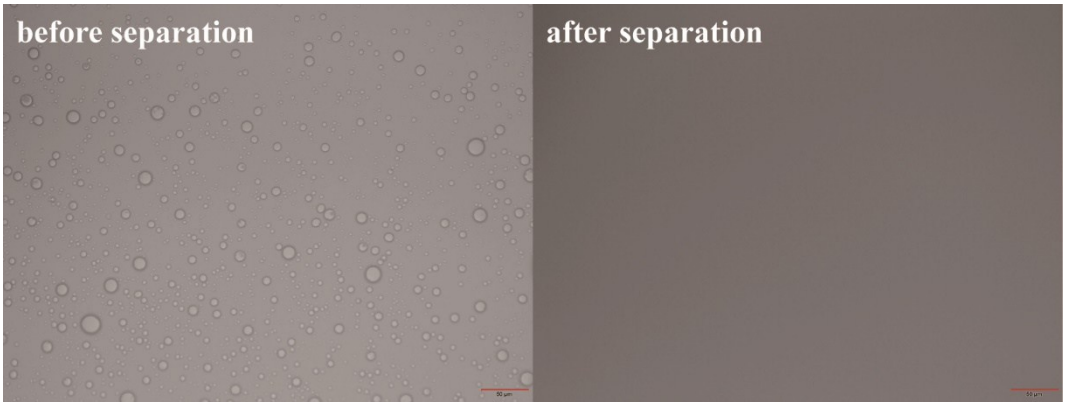

Fig. S9 Microscope photographs of 500/1 water-containing PAO 2 before and after separation using AP-TiO_2-FOTS-coated SSM.

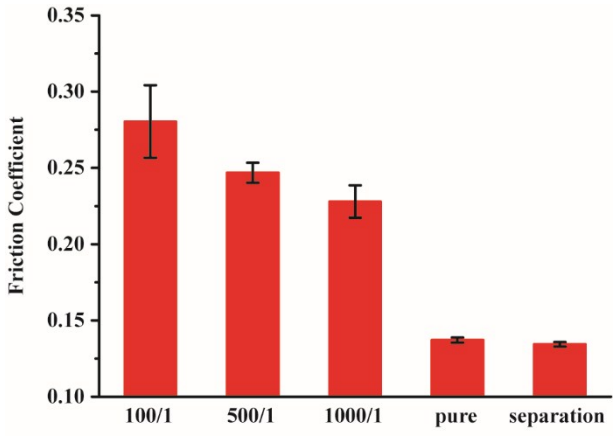

Fig. S10 Average friction coefficient of the test pair in pure, 1000/1 water-containing, 500/1 water-containing, 100/1 water-containing PAO 2, and the purified PAO 2 after separating 500/1 water-containing PAO 2 using AP-TiO_2-FOTS-coated SSM.

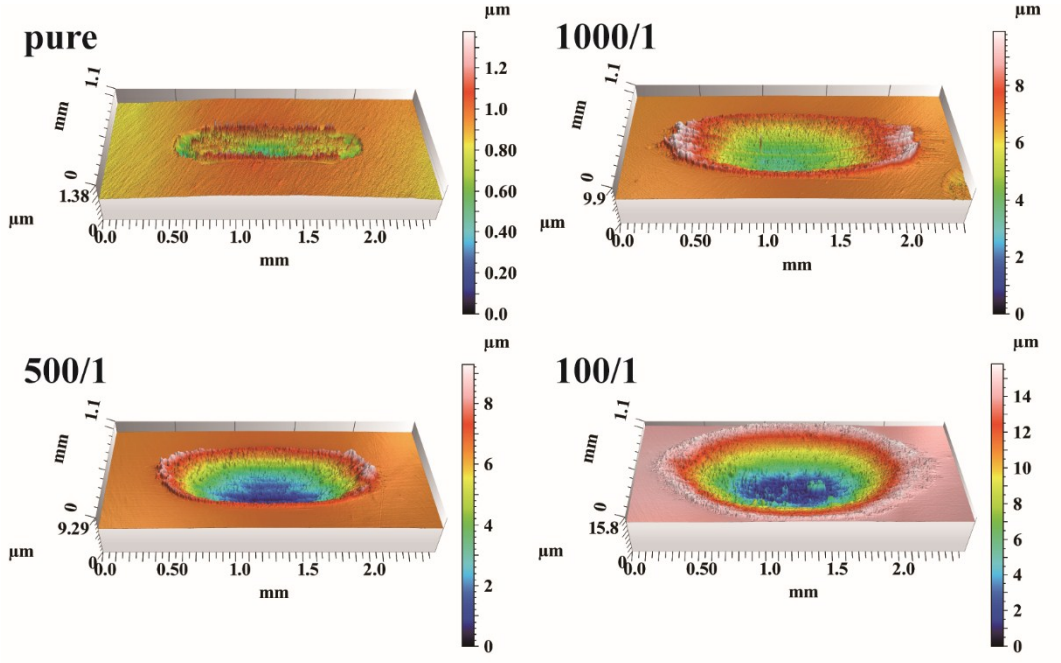

Fig. S11 3D optical microscopic images of wear scars after the tribological tests in pure, 1000/1 water-containing, 500/1 water-containing, and 100/1 water-containing PAO 2.

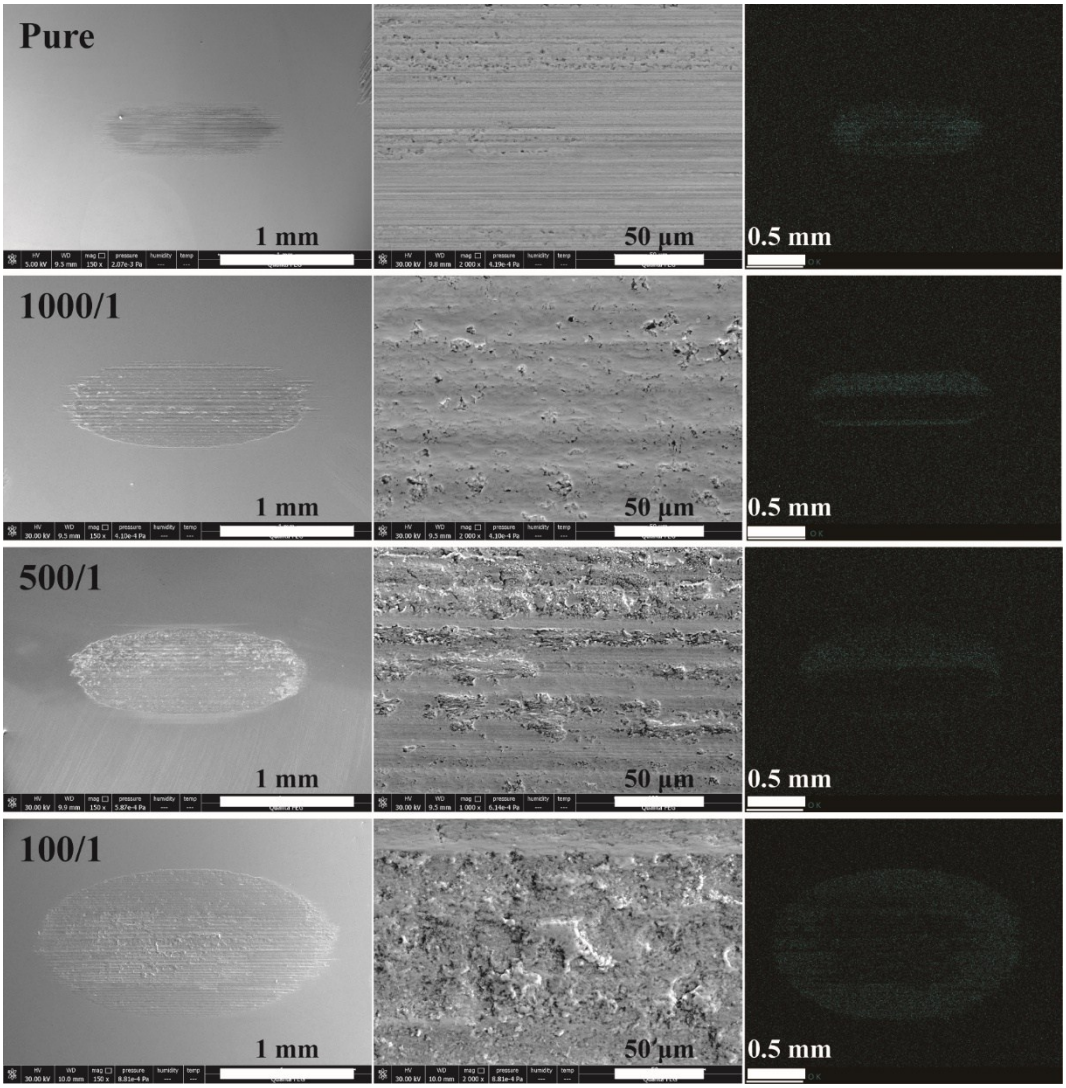

Fig. S12 SEM images (left) and oxygen mapping images (rightmost) of wear scars after the tribological tests in pure, 1000/1 water-containing, 500/1 water-containing, and 100/1 water-containing PAO 2.

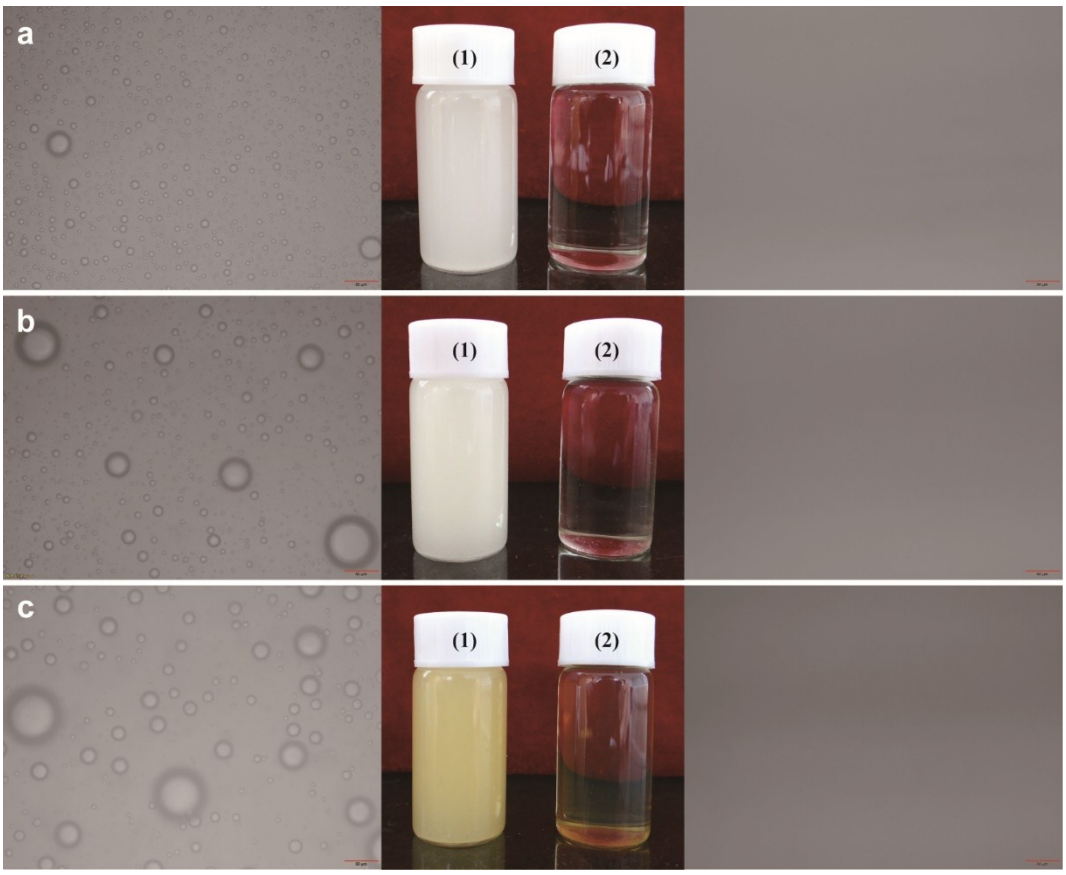

Fig. S13 Photographs of (a) 200/1 water-containing ultra-S8, (b) 10/1 water-containing MACs, and (c) 10/1 water-containing CleanOil 150SN before (left) and after (right) separation using AP-TiO_2-FOTS-coated SSM.

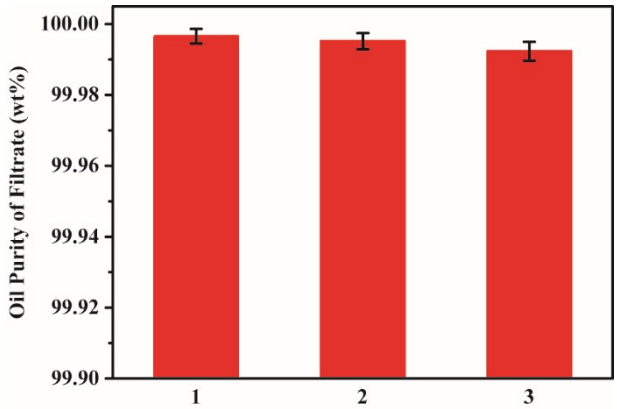

Fig. S14 Purity of (1) 200/1 water-containing ultra-S8, (2) 10/1 water-containing MACs, and (3) 10/1 water-containing CleanOil 150SN after separation using AP-TiO_2-FOTS-coated SSM.

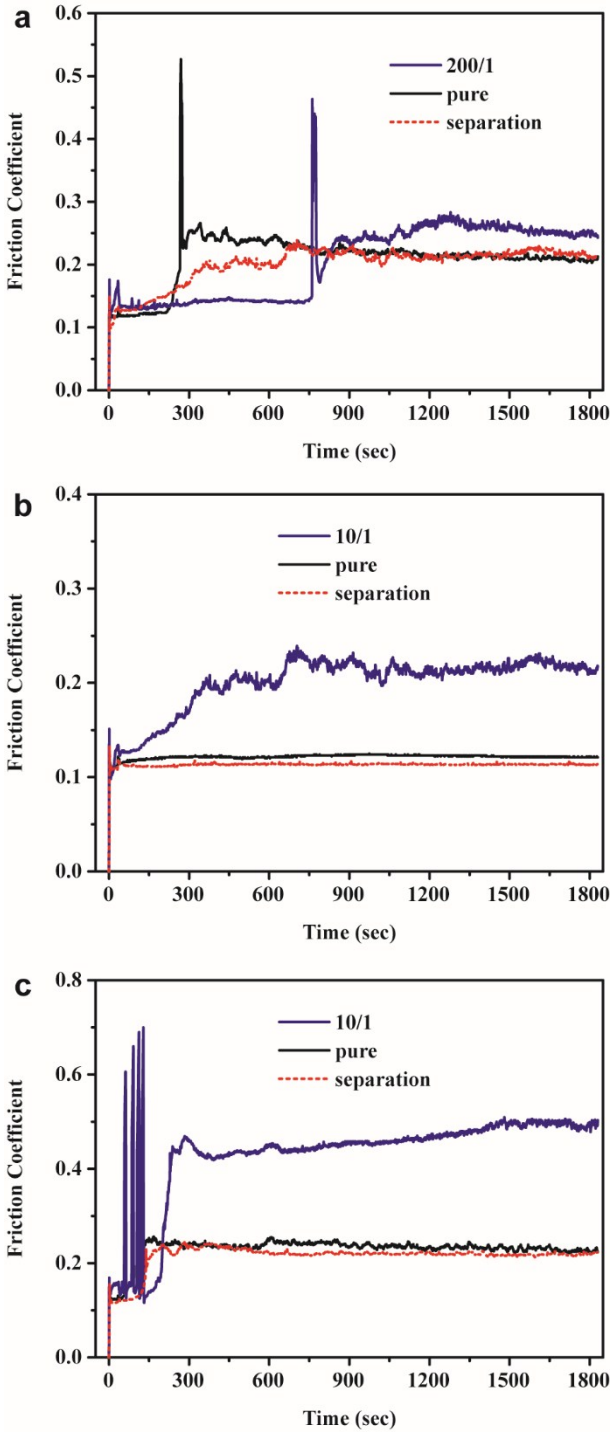

Fig. S15 Friction coefficient of the test pair in pure, water-containing, and purified lubricating oils including (a) ultra-S8, (b) MACs, and (c) CleanOil 150SN.

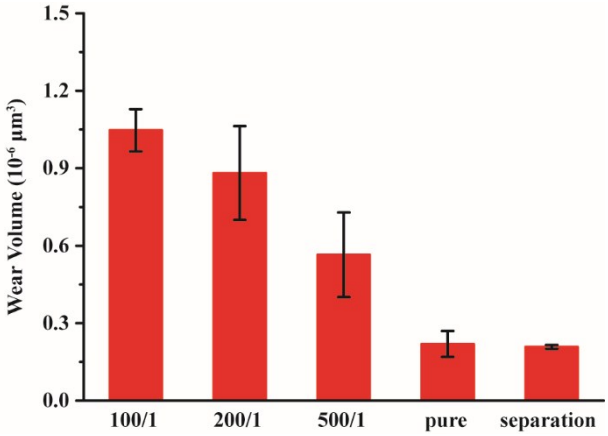

Fig. S16 Wear volume of the test pair in pure, 500/1 water-containing, 200/1 water-containing, 100/1 water-containing ultra-S8, and the purified ultra-S8 after separating 200/1 water-containing ultra-S8 using AP-TiO_2-FOTS-coated SSM.

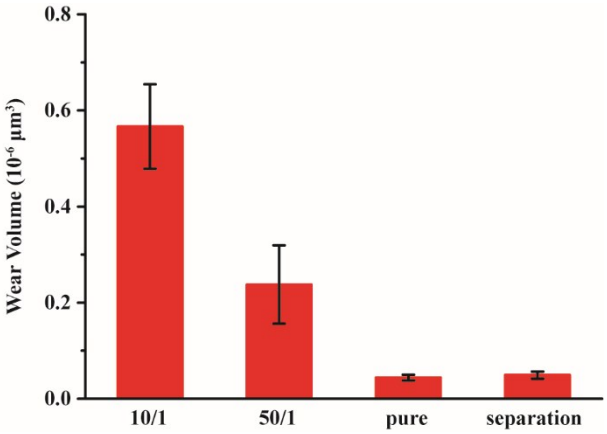

Fig. S17 Wear volume of the test pair in pure, 50/1 water-containing, 10/1 water-containing MACs, and the purified MACs after separating 10/1 water-containing MACs using AP-TiO_2-FOTS-coated SSM.

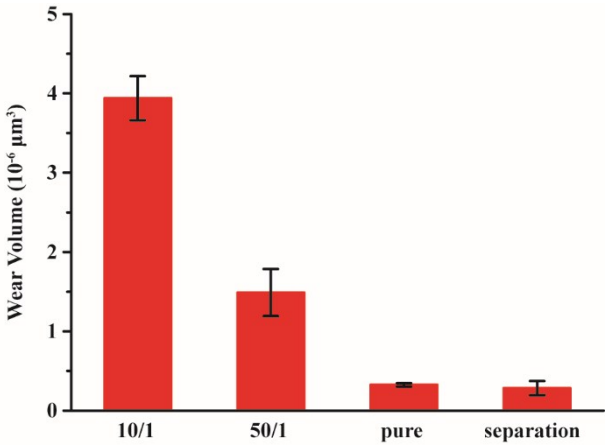

Fig. S18 Wear volume of the test pair in pure, 50/1 water-containing, 10/1 water-containing CleanOil 150SN, and the purified CleanOil 150SN after separating 10/1 water-containing CleanOil 150SN using AP-TiO_2-FOTS-coated SSM.

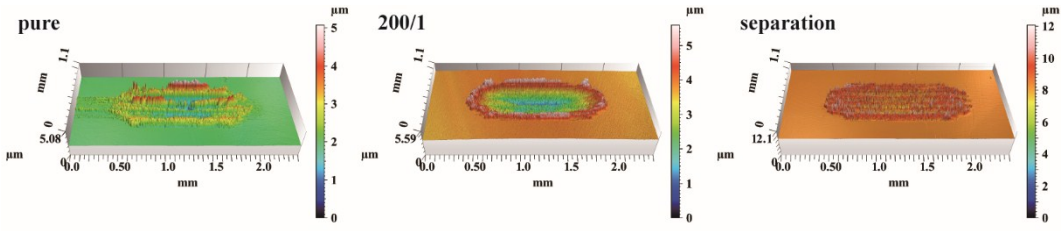

Fig. S19 3D optical microscopic images of wear scars after the tribological tests in pure, 200/1 water-containing ultra-S8, and the purified ultra-S8 after separating 200/1 water-containing ultra-S8 using AP-TiO_2-FOTS-coated SSM.

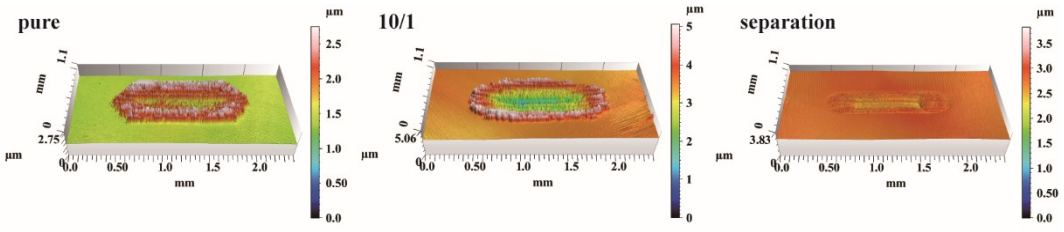

Fig. S20 3D optical microscopic images of wear scars after the tribological tests in pure, 10/1 water-containing MACs, and the purified MACs after separating 10/1 water-containing MACs using AP-TiO_2-FOTS-coated SSM.

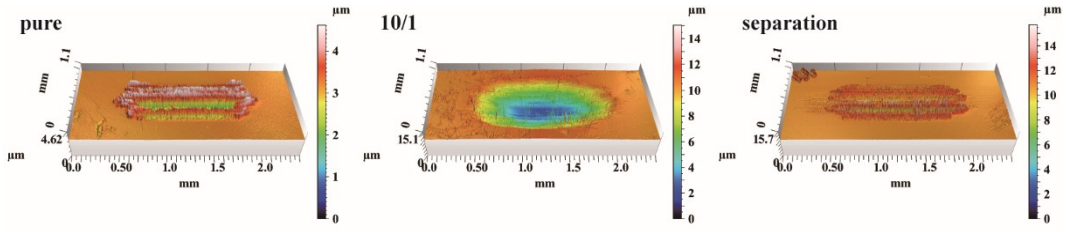

Fig. S21 3D optical microscopic images of wear scars after the tribological tests in pure, 10/1 water-containing CleanOil 150SN, and the purified CleanOil 150SN after separating 10/1 water-containing CleanOil 150SN using AP-TiO_2-FOTS-coated SSM.

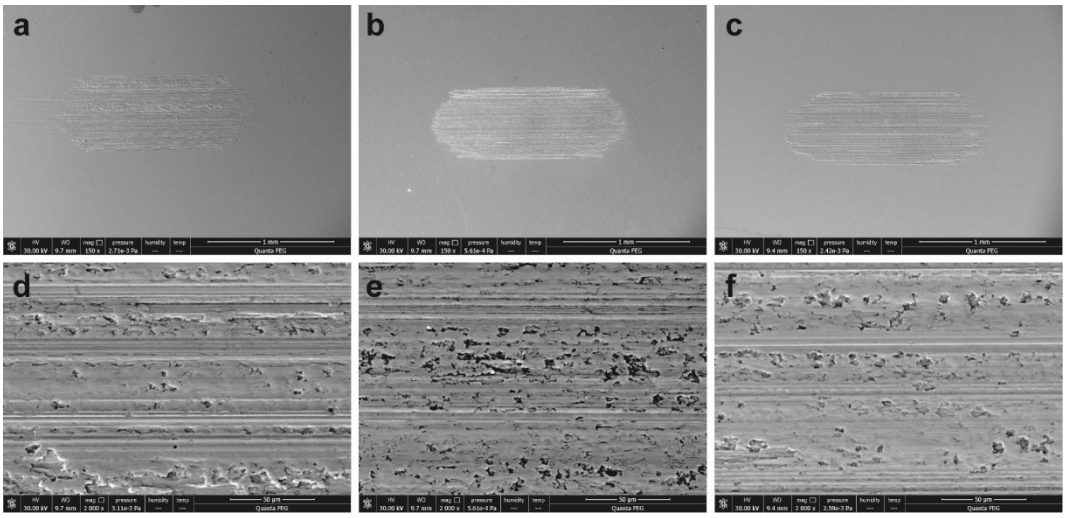

Fig. S22 SEM images of wear scars after the tribological tests in (a, d) pure, (b, e) 200/1 water-containing ultra-S8, and (e, f) the purified ultra-S8 after separating 200/1 water-containing ultra-S8 using AP-TiO_2-FOTS-coated SSM.

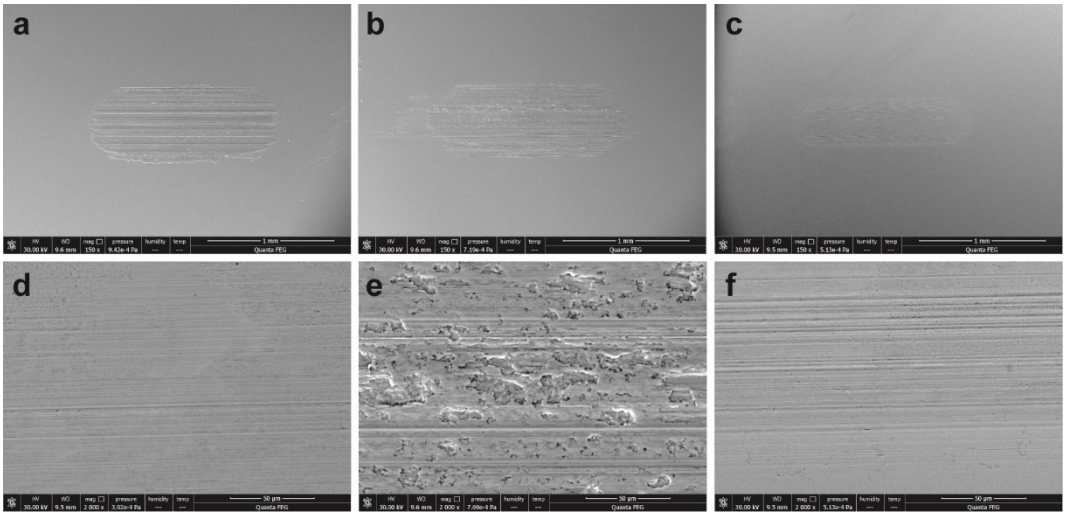

Fig. S23 SEM images of wear scars after the tribological tests in (a, d) pure, (b, e) 10/1 water-containing MACs, and (c, f) the purified MACs after separating 10/1 water-containing MACs using AP-TiO_2-FOTS-coated SSM.

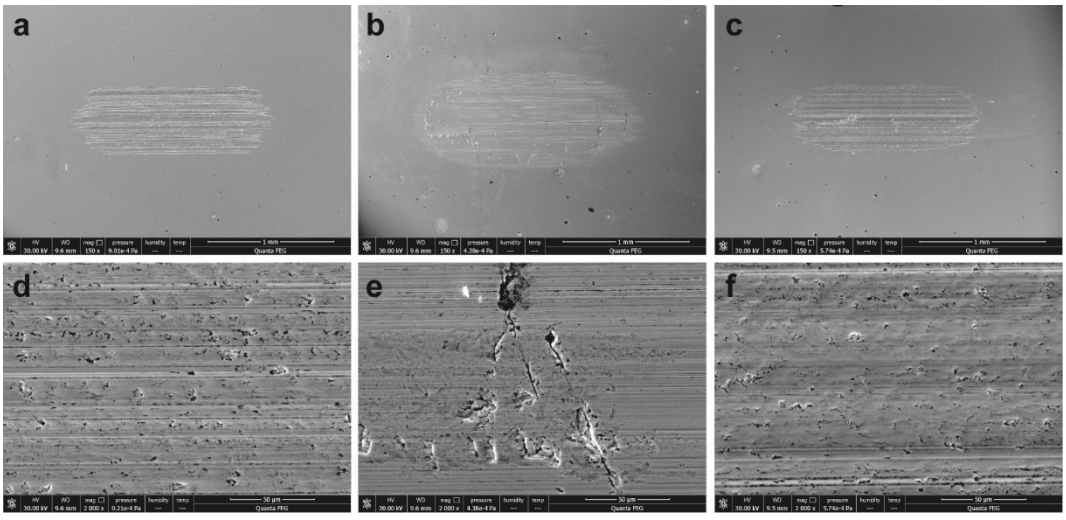

Fig. S24 SEM images of wear scars after the tribological tests in (a, d) pure, (b, e) 10/1 water-containing CleanOil 150SN, and (c, f) the purified CleanOil 150SN after separating 10/1 water-containing CleanOil 150SN using AP-TiO_2-FOTS-coated SSM.

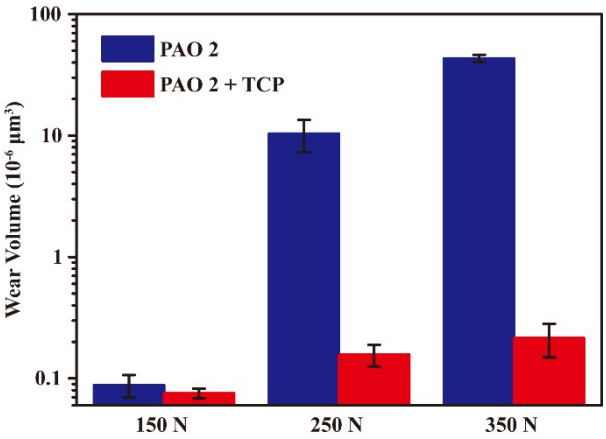

Fig. S25 Wear volume of the test pair in PAO 2 without and with TCP at different contact pressures.

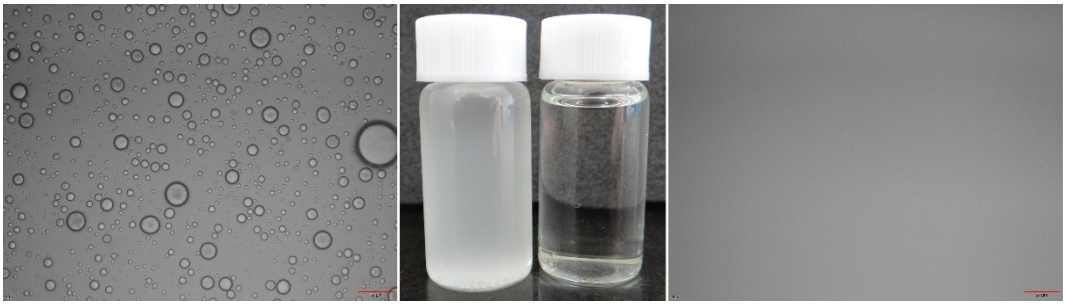

Fig. S26 Photographs of TCP-stabilized water-in-PAO 2 (100/1) emulsion before (left) and after (right) separation using the AP-TiO_2-FOTS-coated SSM.

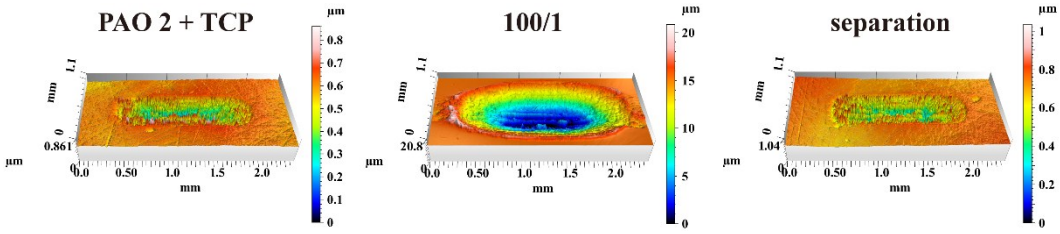

Fig. S27 3D optical microscopic images of wear scars after the tribological tests in TCP-containing PAO 2, TCP-stabilized water-in-PAO 2 (100/1) emulsion, and the purified PAO 2 after separating TCP-stabilized water-in-PAO 2 (100/1) emulsion using the AP-TiO_2-FOTS-coated SSM. The contact pressure is 350 N.

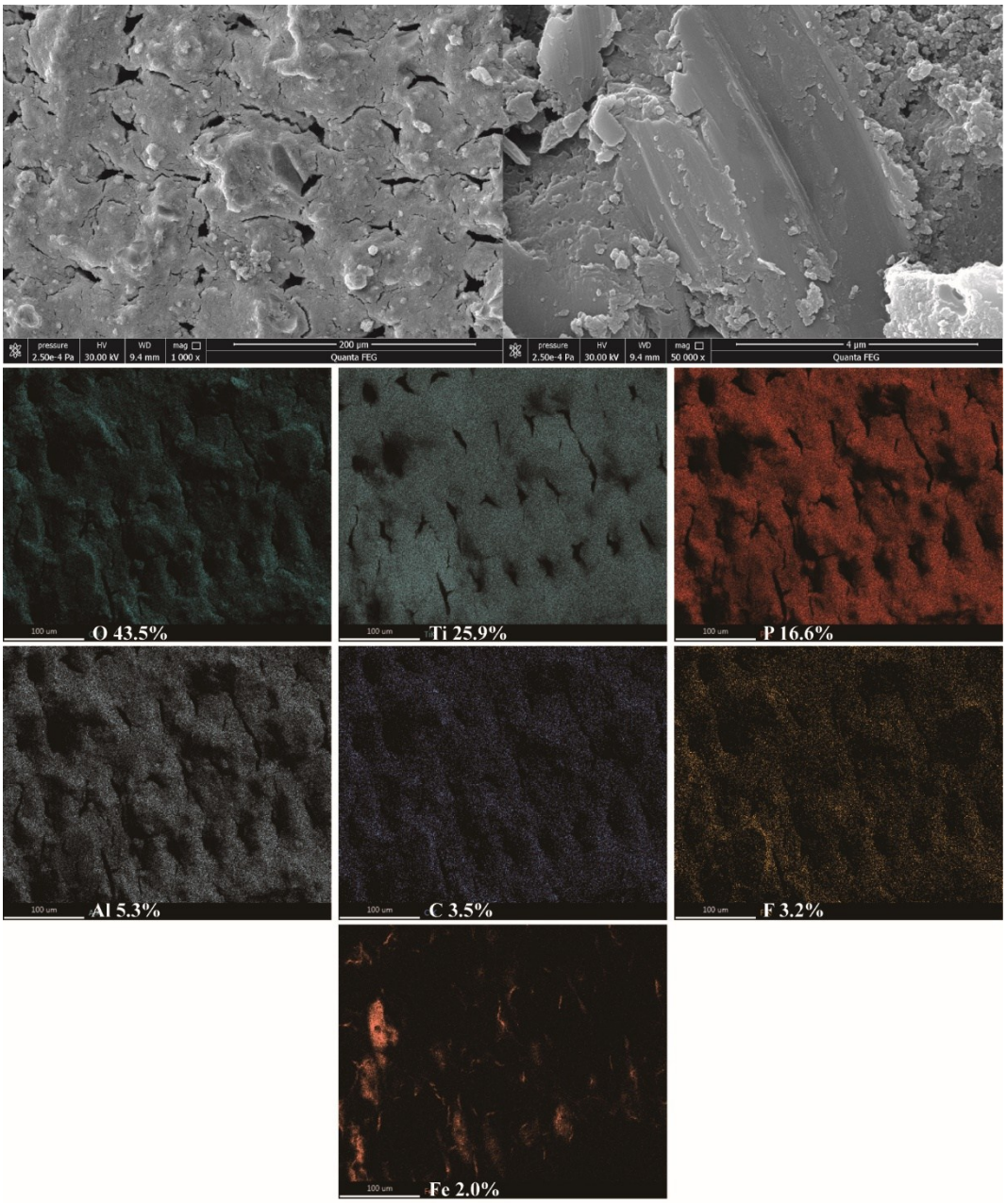

Fig. S28 SEM images, element mapping images, and element weight percentages of AP-TiO_2-FOTS-coated SSM after 50 abrasion cycles with sandpaper.

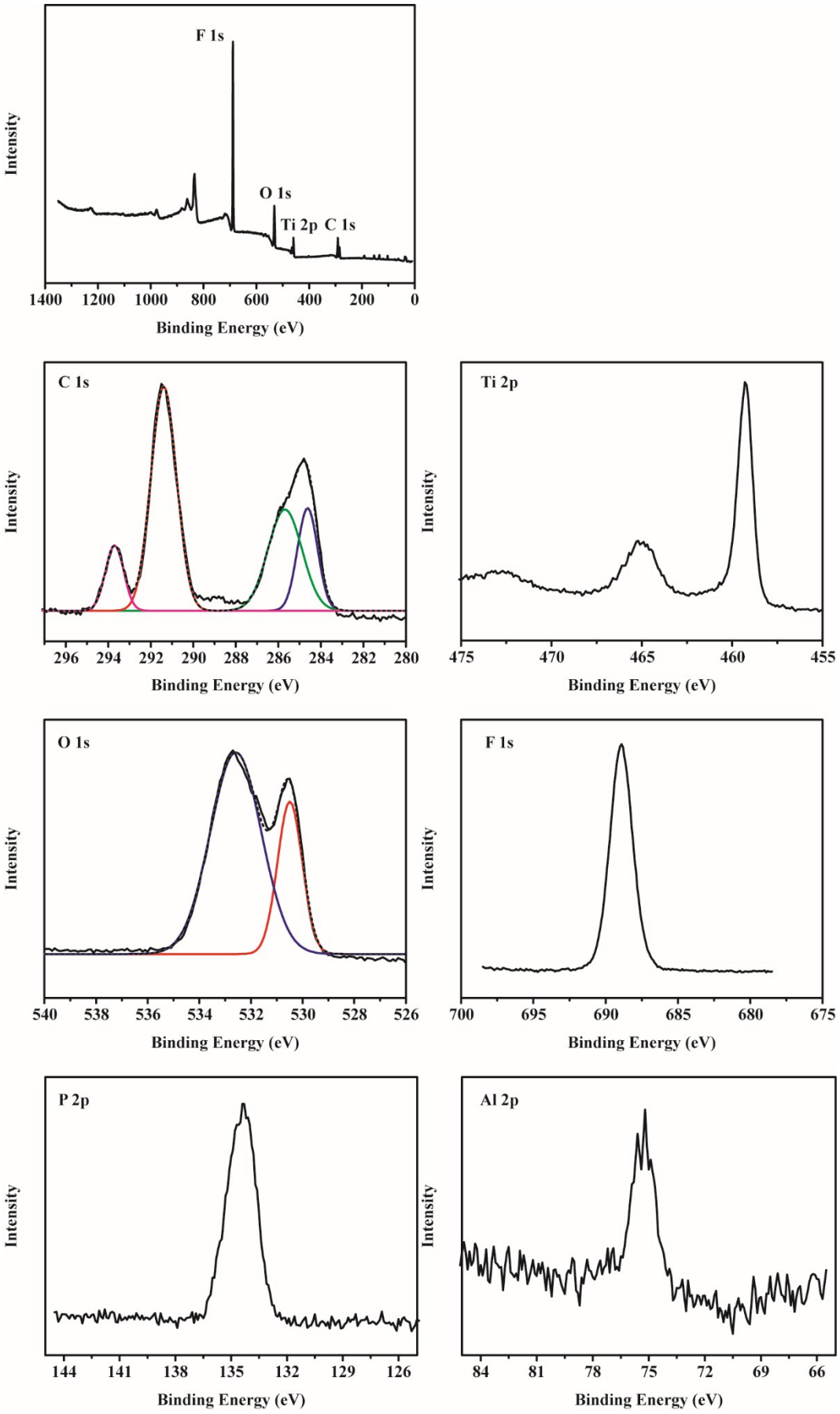

Fig. S29 XPS spectra of AP-TiO_2-FOTS-coated SSM after 50 abrasion cycles.

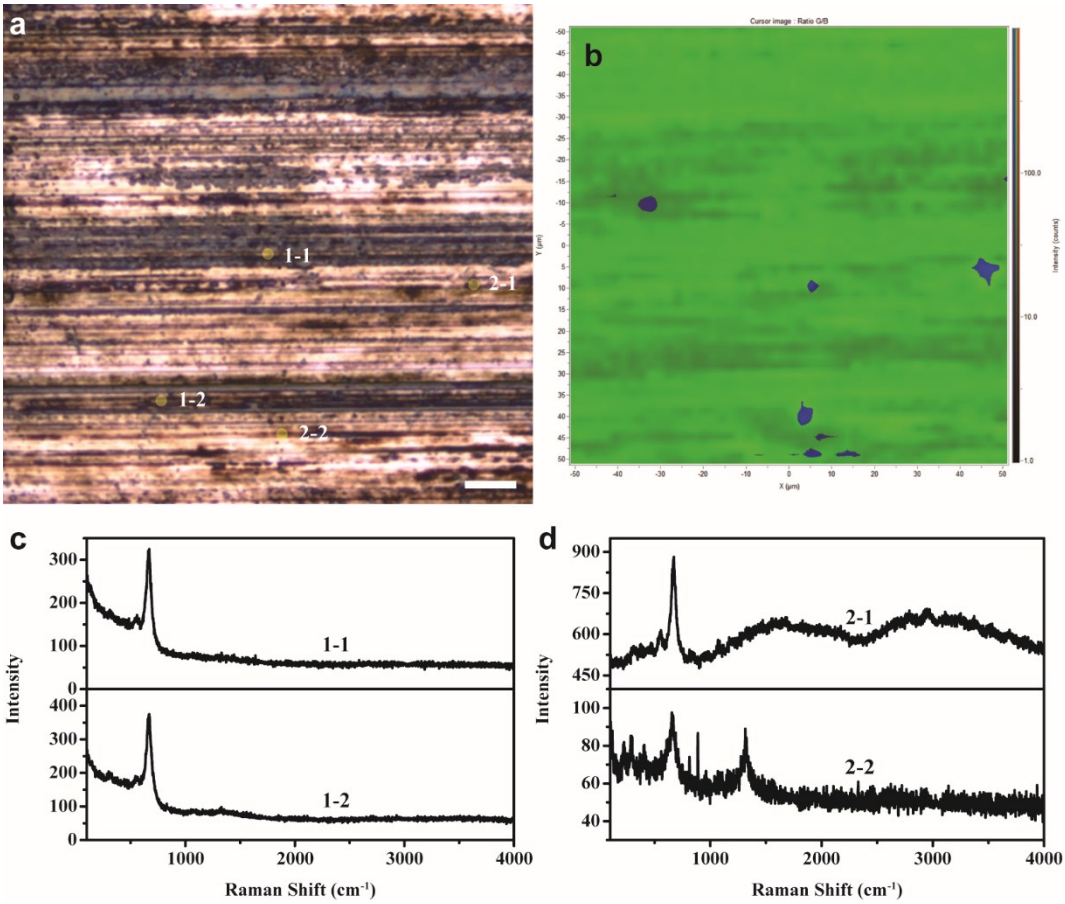

Fig. S30 (a) Optical image of wear scar after the tribological test in pure PAO 2. (b) The points with different color are marked in the confocal Raman images. Green is 400-1000 cm^{-1} and blue is 1000-1800 cm^{-1}. (c, d) The corresponding Raman spectra.

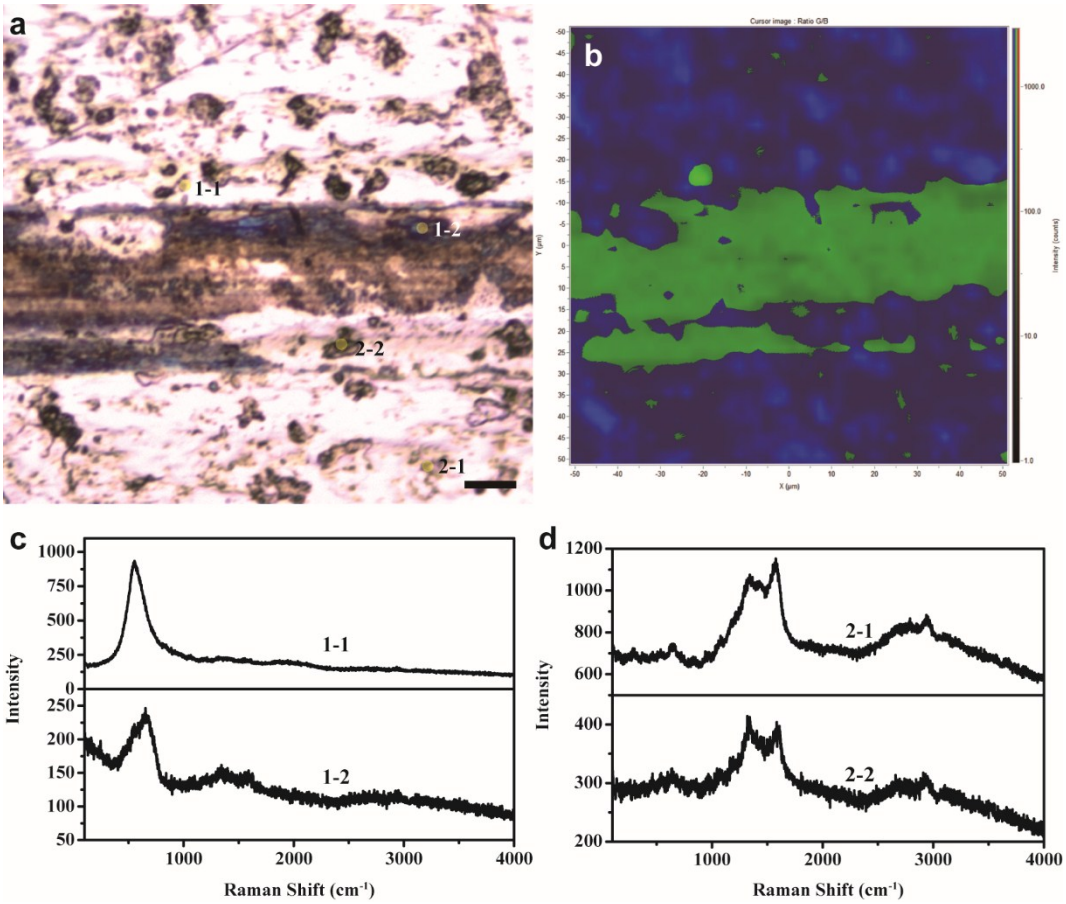

Fig. S31 (a) Optical image of wear scar after the tribological test in 1000/1 water-containing PAO 2. (b) The points with different color are marked in the confocal Raman images. Green is 400-1000 cm^{-1} and blue is 1000-1800 cm^{-1}. (c, d) The corresponding Raman spectra.

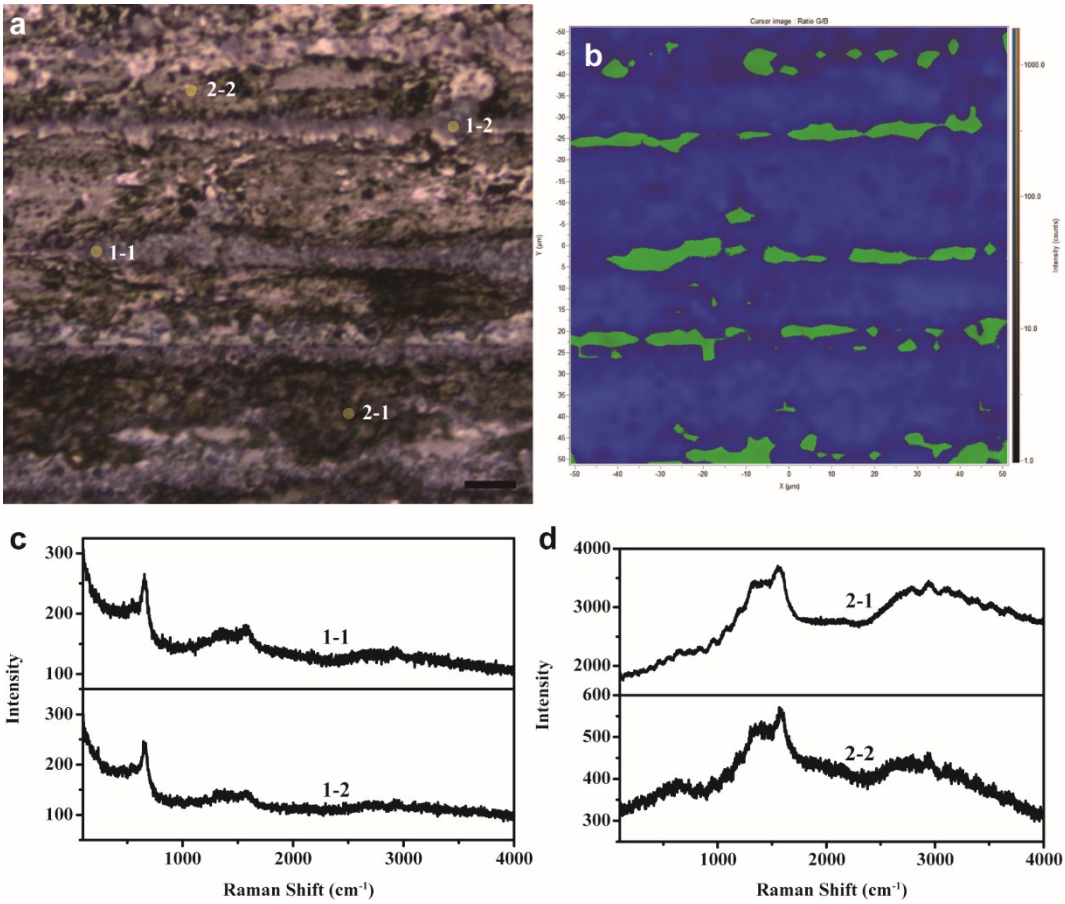

Fig. S32 (a) Optical image of wear scar after the tribological test in 100/1 water-containing PAO 2. (b) The points with different color are marked in the confocal Raman images. Green is 400-1000 cm^{-1} and blue is 1000-1800 cm^{-1}. (c, d) The corresponding Raman spectra.

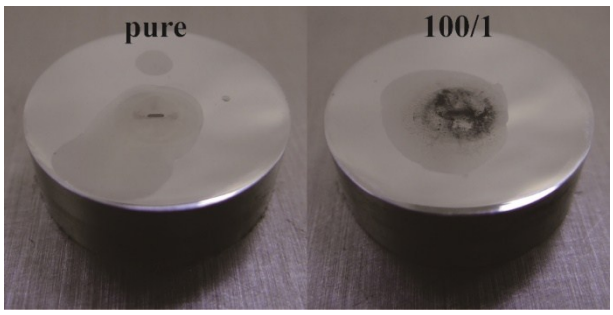

Fig. S33 Photographs of the steel disks after the tribological tests in pure and 100/1 water-containing PAO 2.

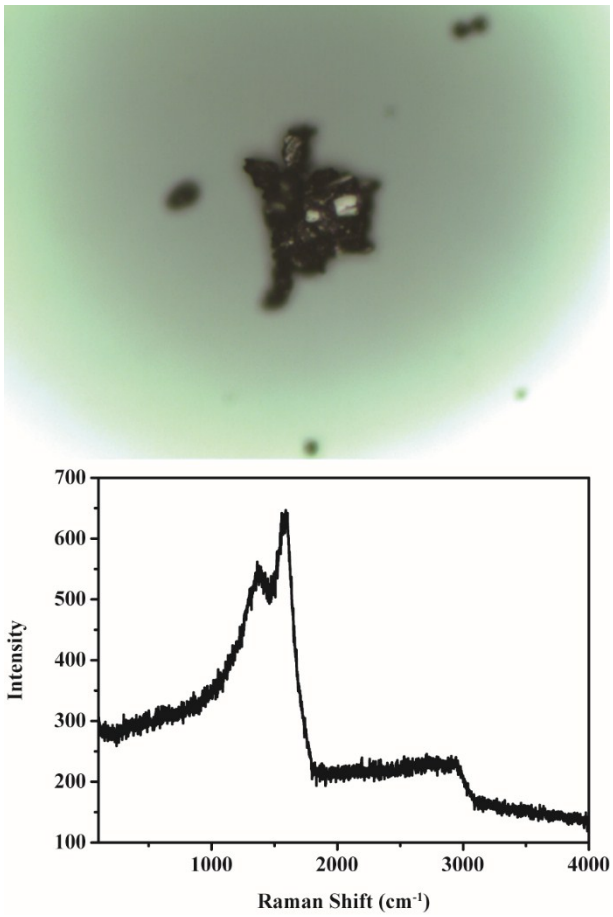

Fig. S34 Optical image and Raman spectrum of wear debris produced from the tribological test in 100/1 water-containing PAO 2. The wear debris particles were deposited on silicon wafer.

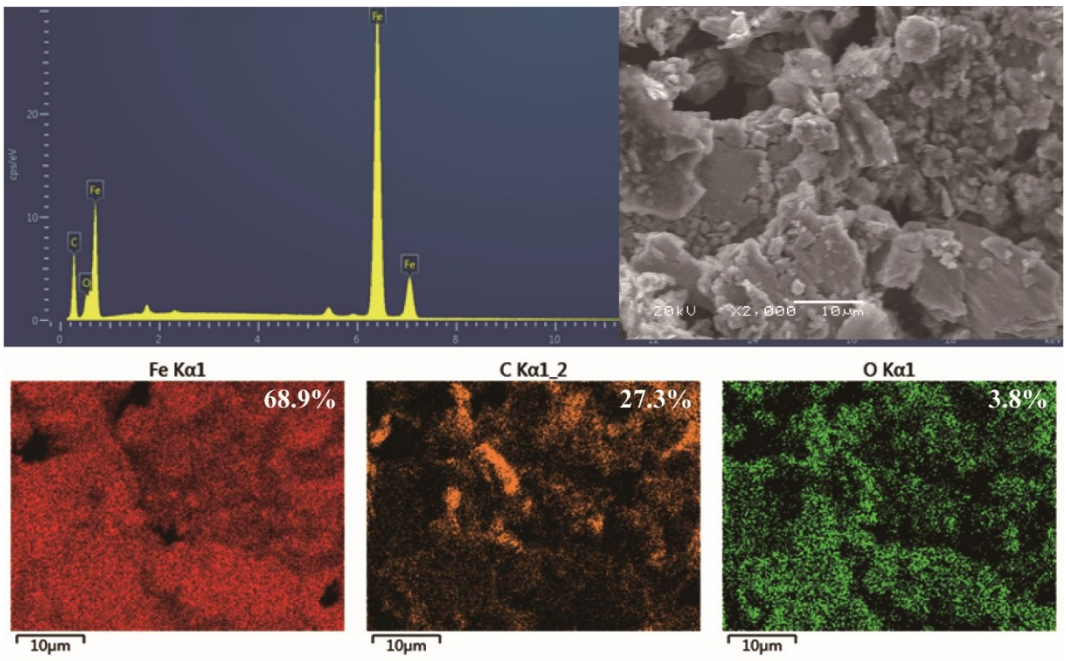

Fig. S35 EDS spectra, SEM image, element mapping images, and element weight percentages of wear debris produced from the tribological test in 100/1 water-containing PAO 2. The wear debris particles were deposited on silicon wafer.