

Supporting information

**Towards outstanding lubricity performance of proton-type
ionic liquids or synergistic effects with Friction Modifier used as oil
additives at steel/steel interface**

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1. Characterization of ILs.

P₆DMA₁₀: ¹H NMR (400 MHz, CDCl₃) δ 3.87 – 3.62 (m, 4H), 3.00 – 2.86 (m, 2H), 2.77 (s, 6H), 1.84 – 1.70 (m, 2H), 1.58 – 1.49 (m, 2H), 1.48 – 1.41 (m, 2H), 1.41 – 1.12 (m, 29H), 0.94 – 0.72 (m, 15H). ¹³C NMR (100 MHz, CDCl₃) δ 67.4, 67.3, 57.3, 42.3, 40.0, 39.9, 31.5, 30.0, 29.1, 29.0, 28.9, 28.8, 28.7, 26.4, 23.9, 23.0, 22.7, 22.3, 13.7, 13.6, 10.6.

P₆DMA₁₂: ¹H NMR (400 MHz, CDCl₃) δ 3.87 – 3.65 (m, 4H), 2.95 – 2.82 (m, 2H), 2.75 (s, 6H), 1.83 – 1.66 (m, 2H), 1.56 – 1.48 (m, 2H), 1.46 – 1.41 (m, 2H), 1.40 – 1.11 (m, 33H), 0.88 (m, 15H). ¹³C NMR (100 MHz, CDCl₃) δ 67.7, 67.6, 57.6, 42.6, 40.3, 40.2, 31.8, 30.0, 29.5, 29.4, 29.3, 29.2, 29.1, 28.9, 26.6, 24.1, 23.3, 23.0, 22.5, 14.0, 10.9.

P₆DMA₁₄: ¹H NMR (400 MHz, CDCl₃) δ 3.84 – 3.65 (m, 4H), 2.98 – 2.84 (m, 2H), 2.74 (s, 6H), 1.75 (s, 2H), 1.53 (m, 2H), 1.44 (m, 2H), 1.38 – 1.17 (m, 37H), 0.88 (m, 15H). ¹³C NMR (100 MHz, CDCl₃) δ 67.4, 67.3, 57.4, 42.4, 40.1, 40.0, 31.6, 29.8, 29.3, 29.3, 29.2, 29.1, 29.0, 28.9, 28.7, 26.5, 24.0, 23.1, 22.8, 22.4, 13.8, 10.7.

2. Characterization of lubrication samples.

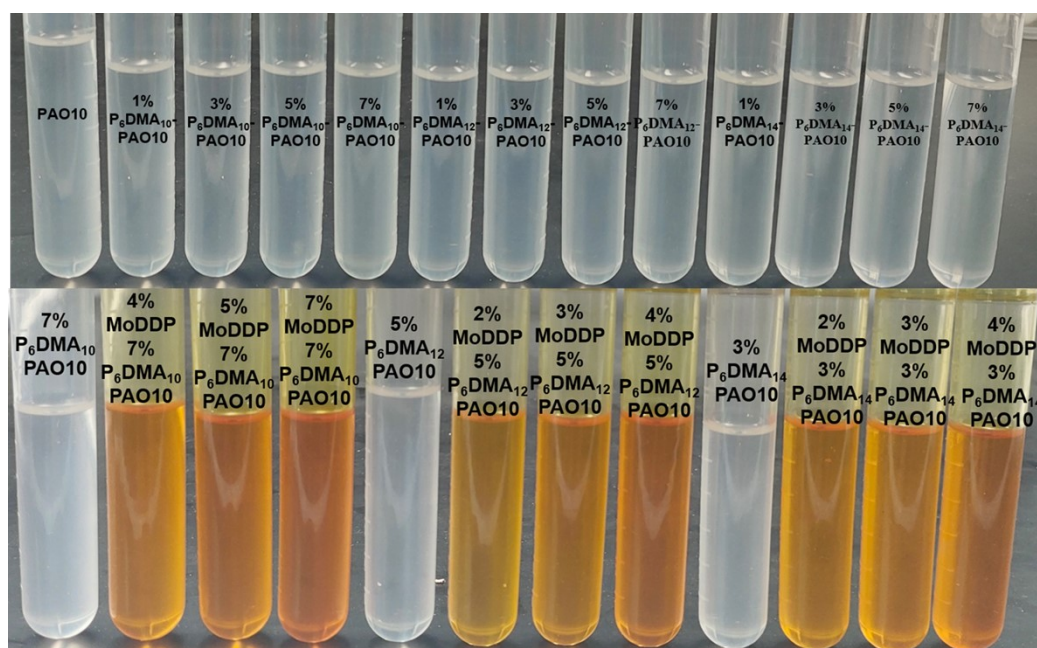


Fig. S1 Optical photograph of all lubricant samples

3. Friction test.

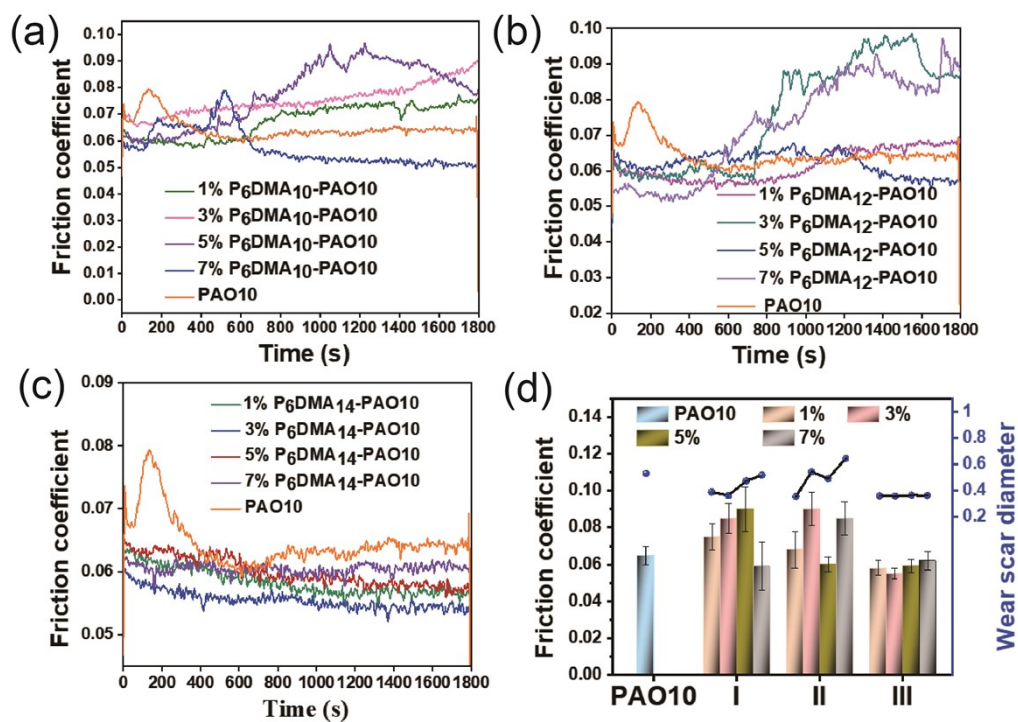


Fig. S2 (a) Evolution of COFs with time of PAO10, PAO10 with the mass addition of $C_1\%$ P₆DMA₁₀ ($C_1=1,3,5,7$) (392 N, 1450r/min, 25 °C) (b) Evolution of COFs with time of PAO10, PAO10 with the mass addition of $C_1\%$ P₆DMA₁₂ ($C_1=1,3,5,7$) (392 N, 1450r/min, 25 °C) (c) Evolution of COFs with time of PAO10, PAO10 with the mass addition of $C_1\%$ P₆DMA₁₄ ($C_1=1,3,5,7$) (392 N, 1450r/min, 25 °C) (d) corresponding average COFs and WSDs of all samples (392 N, 1450r/min, 25 °C).

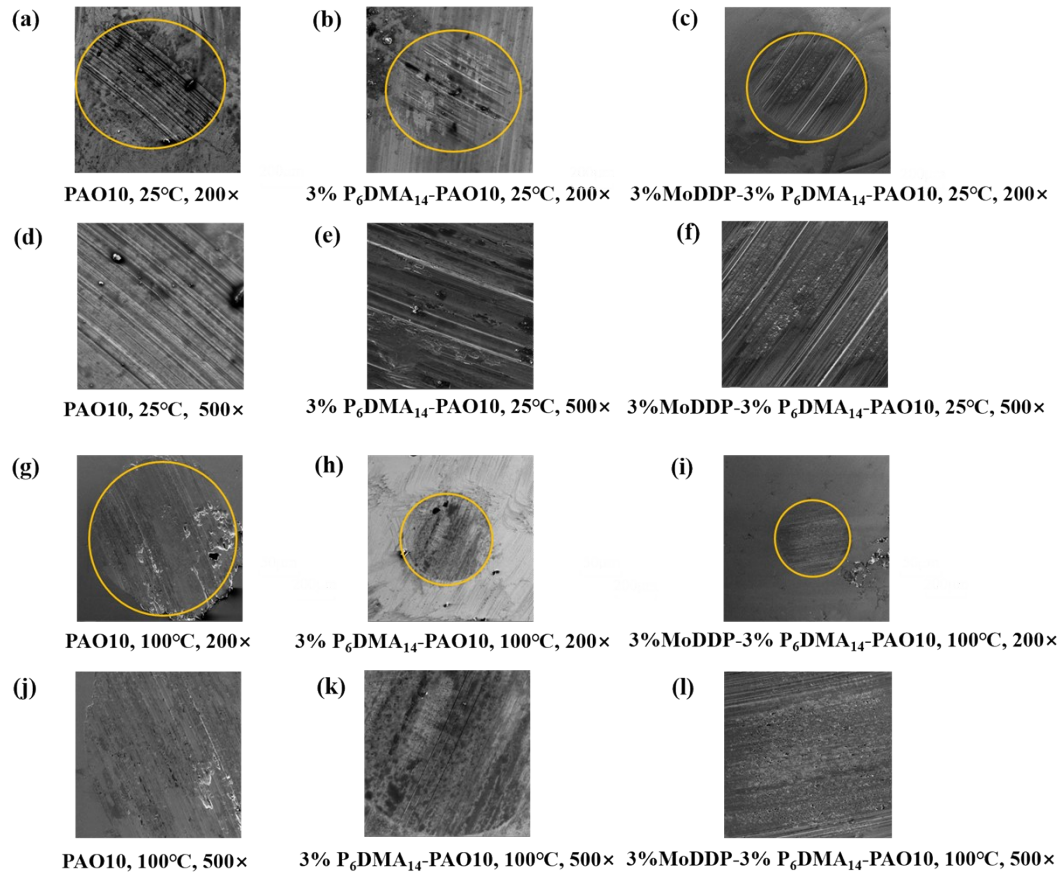


Fig. S3 SEM photographs of different additive components

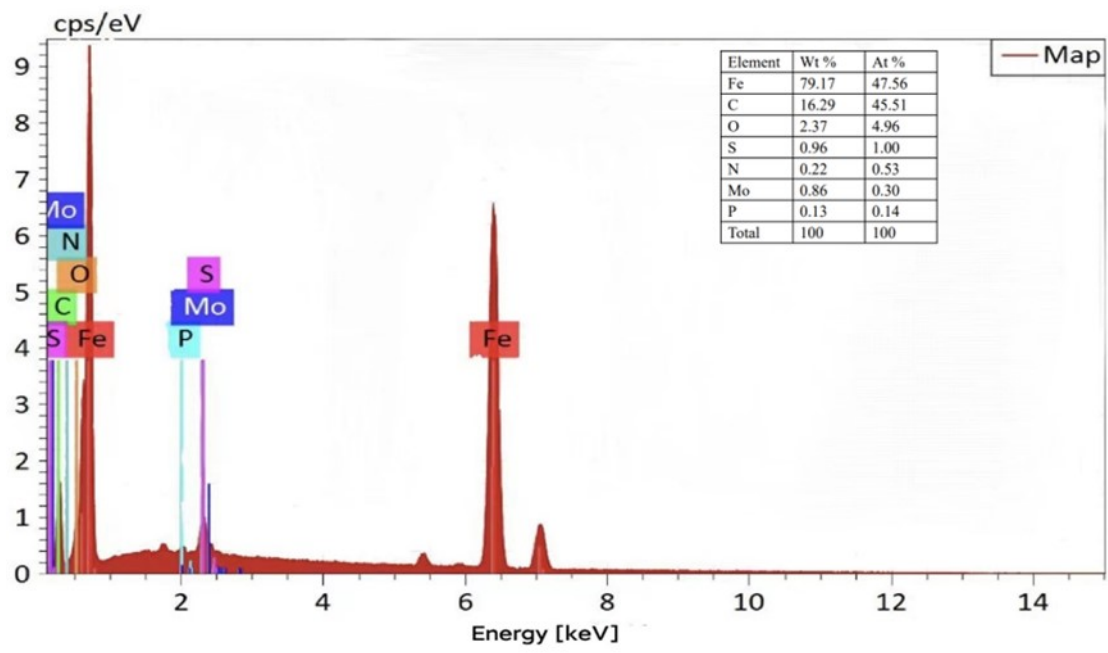
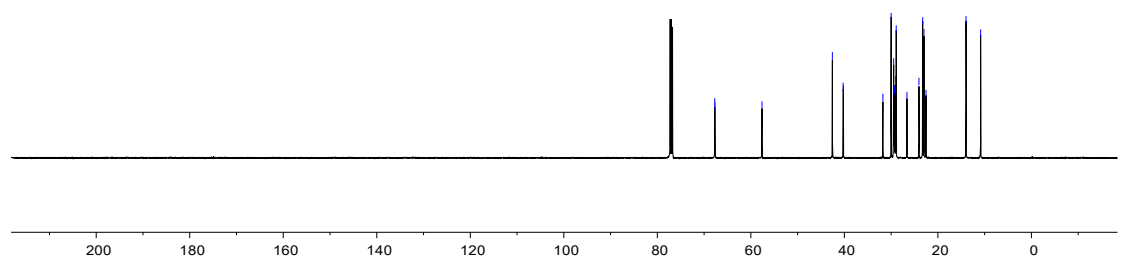
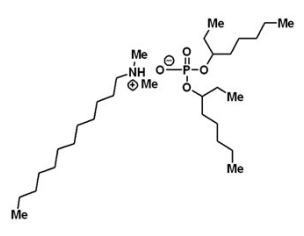
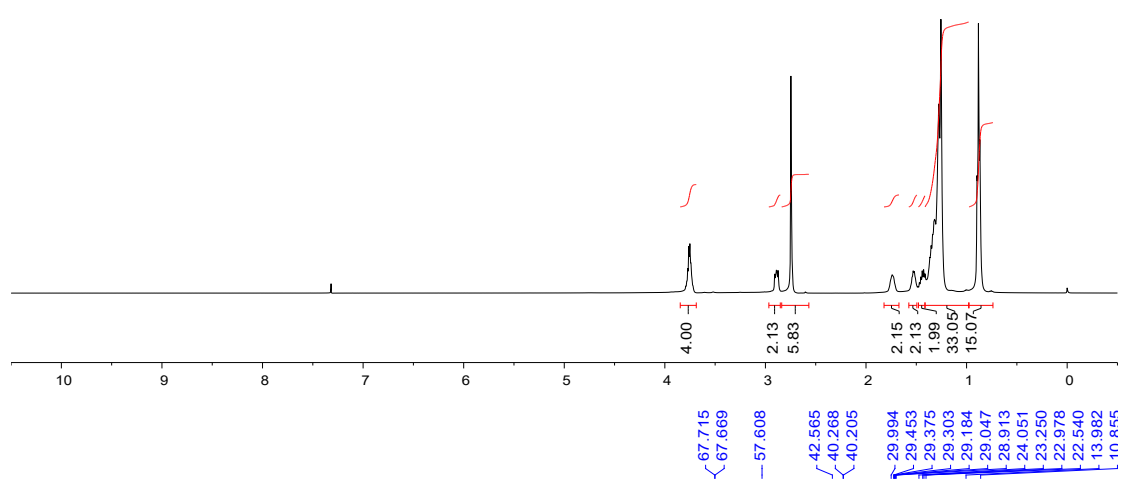
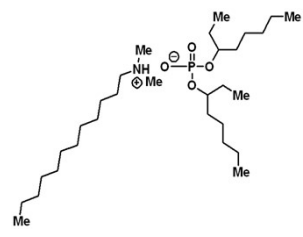


Fig. S4 specific compositional content of the composition

P₆DMA₁₂



P₆DMA₁₄

