Synthesis and Investigation of Phosphorus-free Ionic Liquids as Multifunctional Lubricating Additives

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1. ^{1}H-NMR of synthesized NOA and NDA

The ^{1}H-NMR spectra of starting materials, synthesized NOA and NDA were recorded on a Bruker AVANCE III 400 MHz spectrometer. $CDCl_3$ was used as solvent.

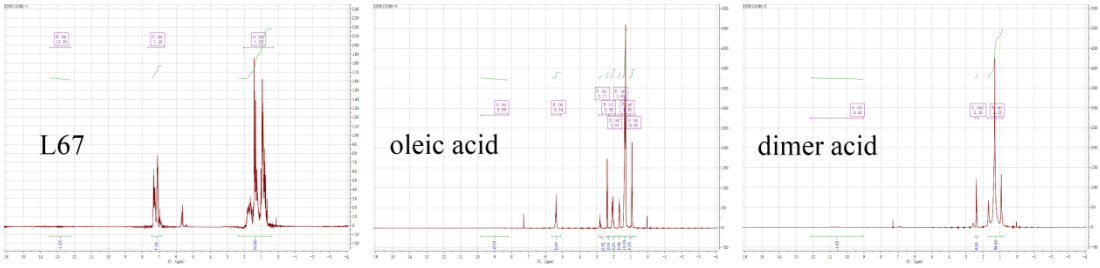

Figure S1 1H-NMR of starting materials

Nonylated diphenylamine (L67)

^{1}H-NMR (400 MHz, CDCl3) δ (ppm): 12.85 (m, 1H, -NH), 7.19 (m, 8H, arom), 0.38-2.32 (m, 30H, -CH_2/-CH_3)

Oleic acid

^{1}H NMR (400 MHz, CDCl3) δ (ppm): 12.85 (m, 1H, -COOH), 5.34 (m, 2H, -CH=CH-), 2.03-2.77 (m, 6H, -CH_2-CO-/-CH_2-C=C), 0.92-2.03 (m, 25H, -CH_3/-CH_2)

Dimer acid

^{1}H-NMR (400 MHz, CDCl3) δ (ppm): 9.48 (d, 2H, -COOH), 2.38 (dd, 4H, -CH_2-CO-), 0.69-1.79 (m, 58H, -CH_3/-CH_2)

NOA

^{1}H-NMR (400 MHz, $CDCl_3$) δ (ppm): 7.19 (m, 8H, arom), 5.46 (m, 2H, -CH=CH-), 2.36 (m, 2H, -CH_2-CO-), 0.48-2.18 (m, 59H, -CH_3/-CH_2)

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NDA

^{1}H-NMR (400 MHz, $CDCl_3$) δ (ppm): 7.14 (m, 16H, arom), 2.40 (m, 4H, -CH_2-CO-), 0.42-2.13 (m, 119H, -CH_3/-CH_2)

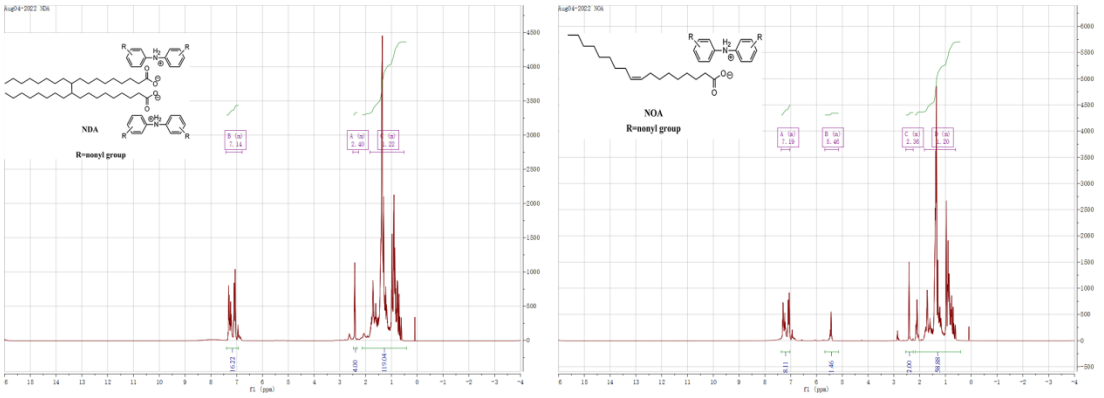

Figure S2 1H-NMR of synthesized ionic liquid

Due to the influence of hydrogen bond, the active hydrogen does not show obviously. Referring to ^{1}H-NMR of oleic acid and dimer acid, it confirmed the existence of NDA and NOA. The complex peak in δ=1-2 is due to the impurities from Nonylated diphenylamine (L67), because L67 is a commercial sale mixture.