

*An experimental investigation on the thermo-rheological behaviors of lactic acid based natural deep eutectic solvents*

*Yousef Elhamarnah<sup>b</sup>, Wadha Almarri<sup>b</sup>, Asma Albadr<sup>b</sup>, Alanoud Almalki<sup>b</sup>, Mashael AlRasheedi<sup>b</sup>, Nora Mohamed<sup>b</sup>, Izzah Fatima<sup>b</sup>, Mustafa Nasser<sup>ab\*</sup>, Hazim Qiblawey<sup>b</sup>*

*<sup>a</sup> Gas Processing Center, College of Engineering, Qatar University, Doha, Qatar*

*<sup>b</sup> Department of Chemical Engineering, College of Engineering, Qatar University, Doha, Qatar*

*Corresponding Author: Mustafa Nasser [m.nasser@qu.edu.qa](mailto:m.nasser@qu.edu.qa)*

**Supplementary information**

**Table S1:** Shear flow parameters

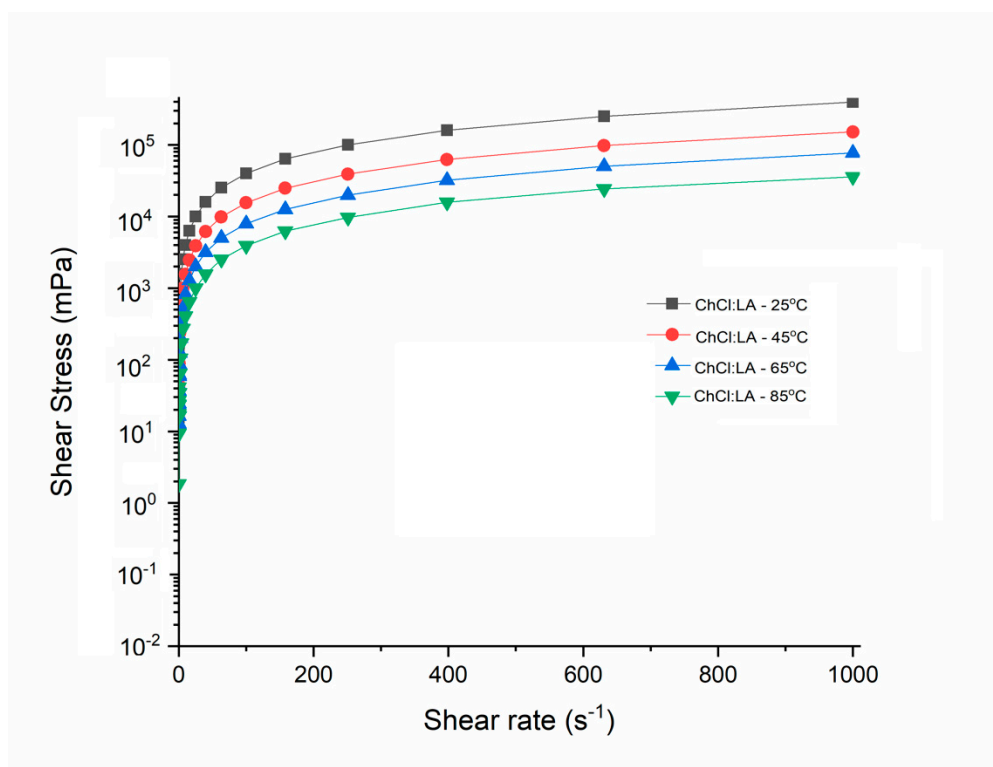
Parameter	value
Shear rate (1/s)	0.01-1000
Data points	50
Single point duration (s)	12
Temperature range (°C)	25, 45,65,85,105

**Table S2:** Pre-Shear flow parameters

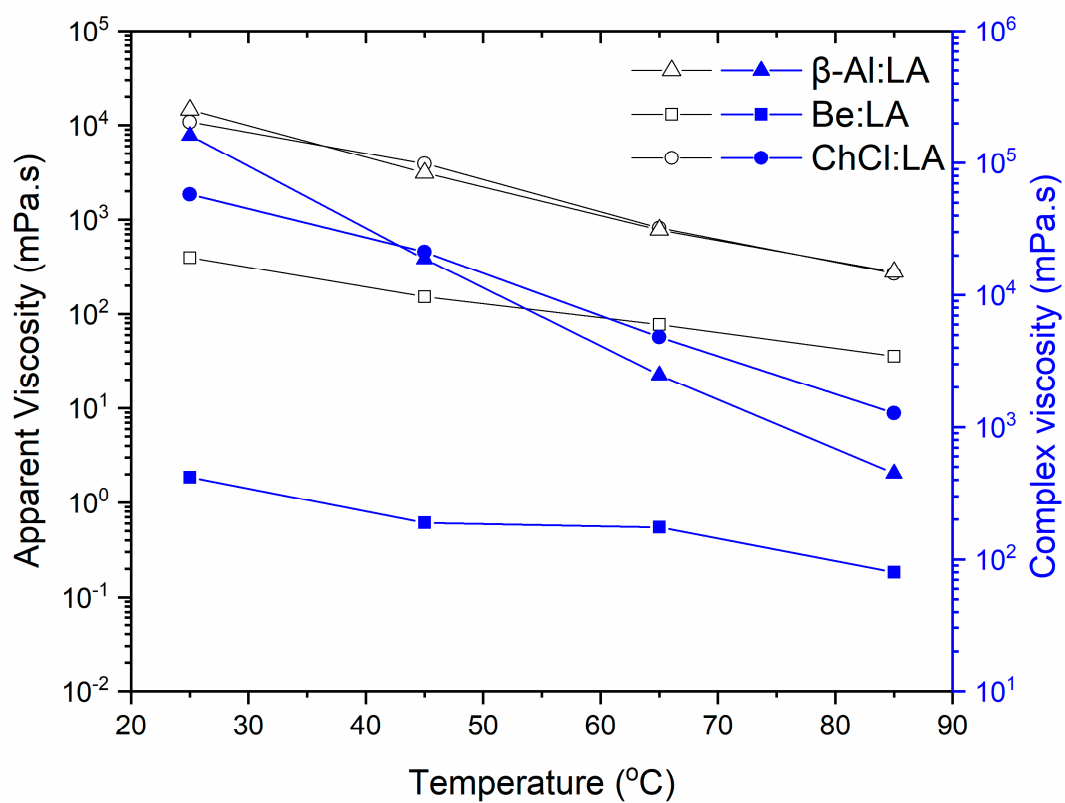
Parameter	value
Shear rate (1/s)	0.01 (constant)
Data points rate (point/s)	5

**Table S3:** Oscillatory shear flow parameters

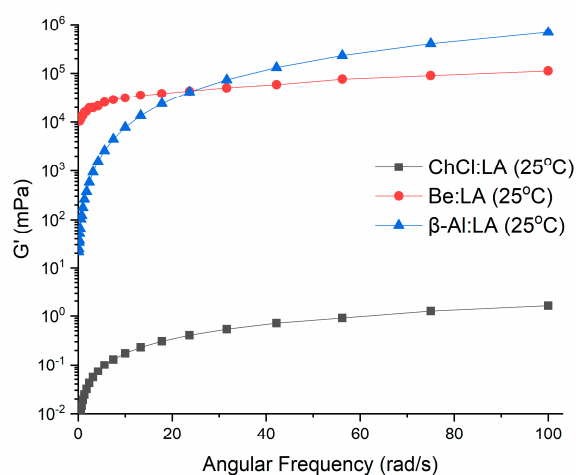
Parameter	value
Shear strain (%)	10 (oscillating)
Data points rate (Point/s)	25
Initial angular frequency (rad/s)	100
Final angular frequency (rad/s)	0.1



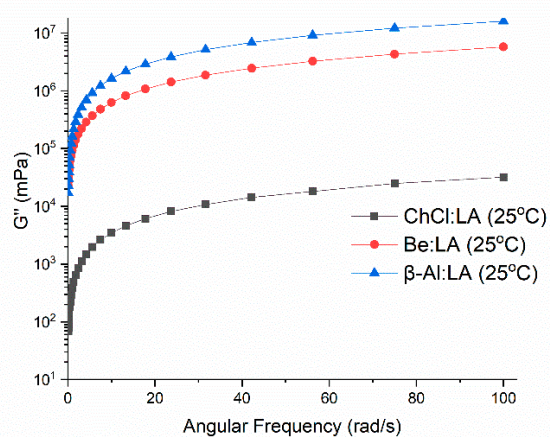
**Figure S1.** The variation of shear stress as a function of applied shear rate for ChCl:LA NADES systems at different temperatures from 25-85 °C



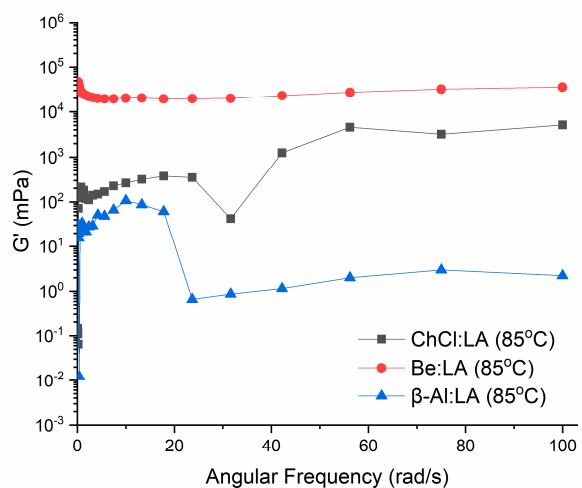
**Figure S2.** Complex viscosity & apparent viscosity variation for Be, B-Al, ChCl:LA NADES systems at high angular frequency (100 rad. s<sup>-1</sup>) and high shear rate (1000 s<sup>-1</sup>) under heating from ambient temperature conditions to 85°C



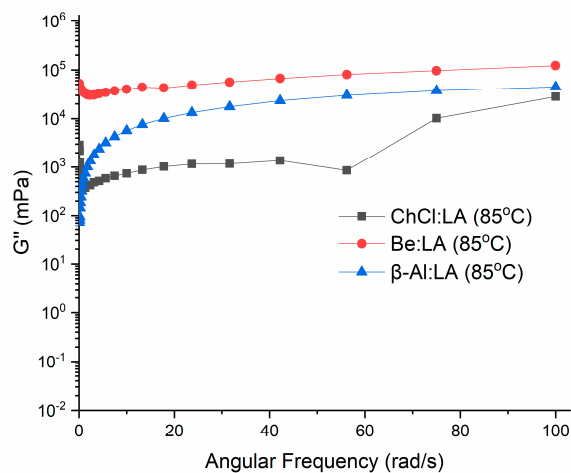
a



b



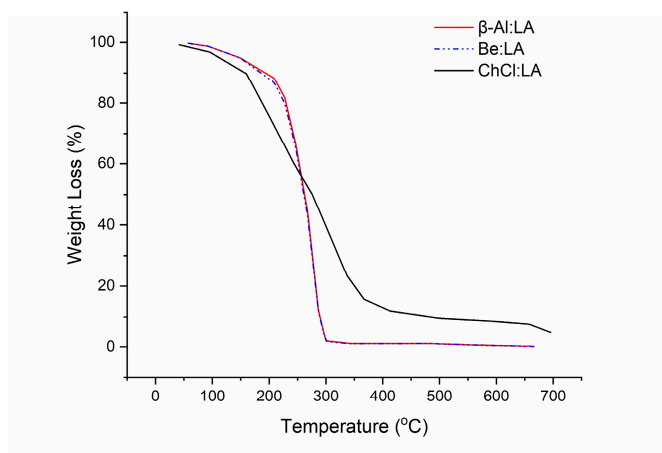
c



d

**Figure S3.** (a) The elastic modulus ( $G'$ ) at an angular frequency range from 0.1–100  $\text{rad} \cdot \text{s}^{-1}$  for Be, B-Al, and ChCl:LA at room temperature conditions. (b) The viscous modulus ( $G''$ ) at an angular frequency range from 0.1–100  $\text{rad} \cdot \text{s}^{-1}$  for Be, B-Al, and ChCl:LA at room temperature conditions. (c) The elastic modulus ( $G'$ ) at an angular

frequency range from 0.1–100 rad. s<sup>-1</sup> for Be, B-Al, and ChCl:LA at high temperature. (d) The viscous modulus ( $G''$ ) at an angular frequency range from 0.1–100 rad. s<sup>-1</sup> for Be, B-Al, and ChCl:LA at high temperature.



**Figure S4.** TGA thermographs of LA-based NADES systems.