

**Supporting Information**

**Biodegradable Glucosamine-Amino Acid-Based Ionic  
Liquids as Efficient Water-Based Lubricant Additives for  
Green Tribological Chemistry**

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The formulas for calculating the biodegradation rate are shown below:

BOD is the amount of oxygen consumed by microorganisms to decompose organic matter and is calculated as shown in (S1):

$$\text{BOD} = \frac{m_1 - m_2}{m_3} \quad (\text{S1})$$

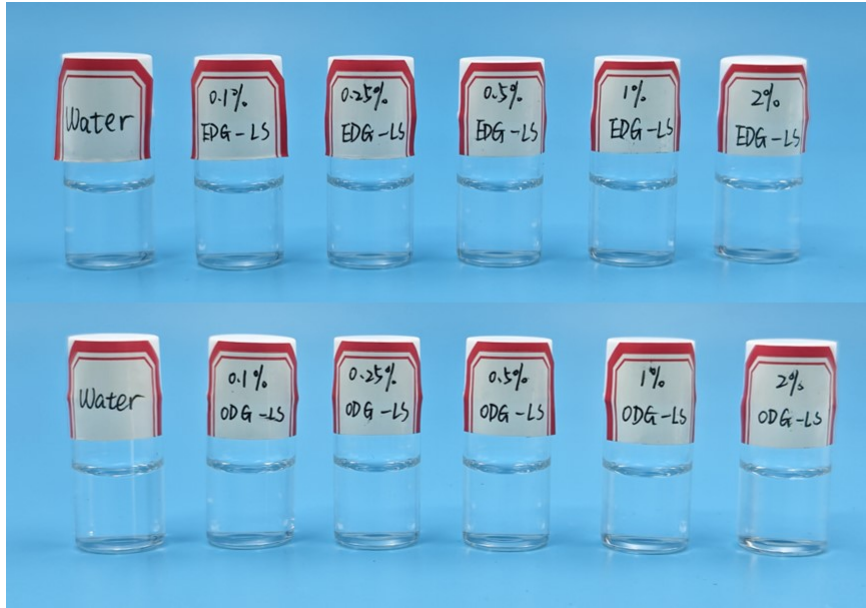
where  $m_1$  represents the oxygen consumption of the subject (mg);  $m_2$  represents the oxygen loss of the blank control (mg); and  $m_3$  represents the amount of the subject added (mg).

ThOD is the total amount of oxygen required for the complete oxidation of the test substance calculated from the molecular formula, let the molecular formula of the test substance be  $\text{C}_c\text{H}_h\text{N}_n\text{O}_o$ , MW denotes the molecular mass of the test substance, and the formula is shown in (S2):

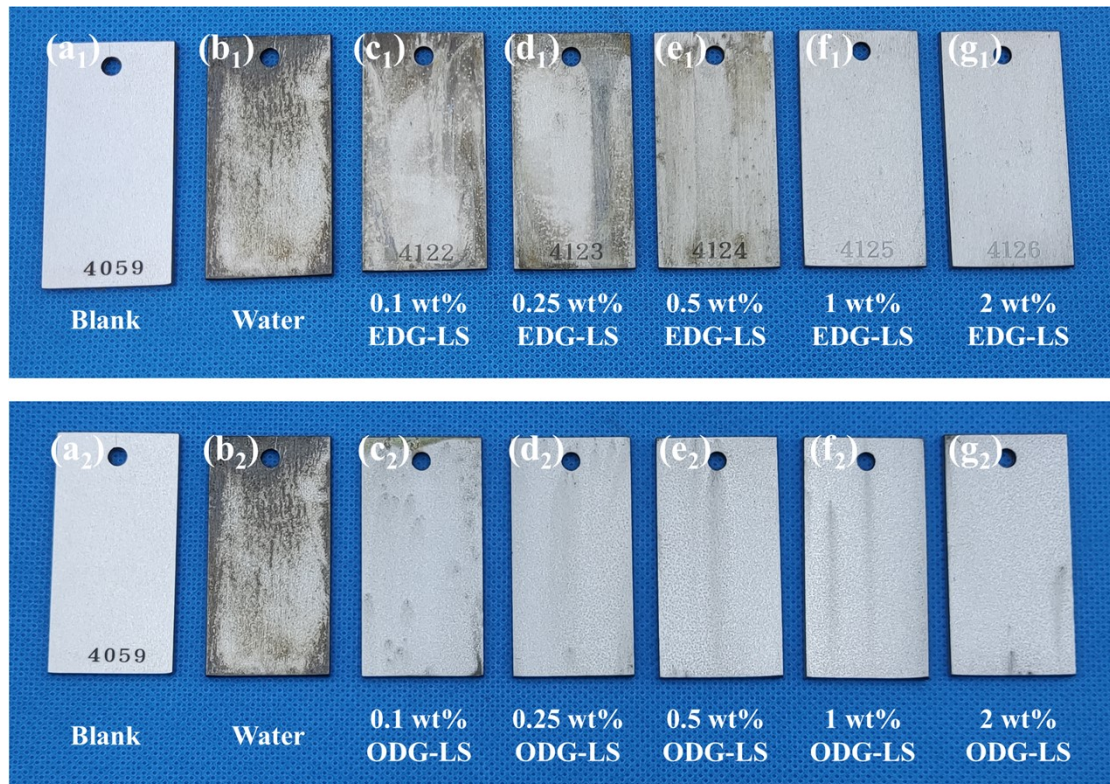
$$\text{ThOD} = \frac{16 \left[ 2c + \frac{1}{2}(h - 3n) - o \right]}{\text{MW}} \quad (\text{S2})$$

The formula for calculating the biodegradation rate (D) is shown in (S3) and is expressed in %:

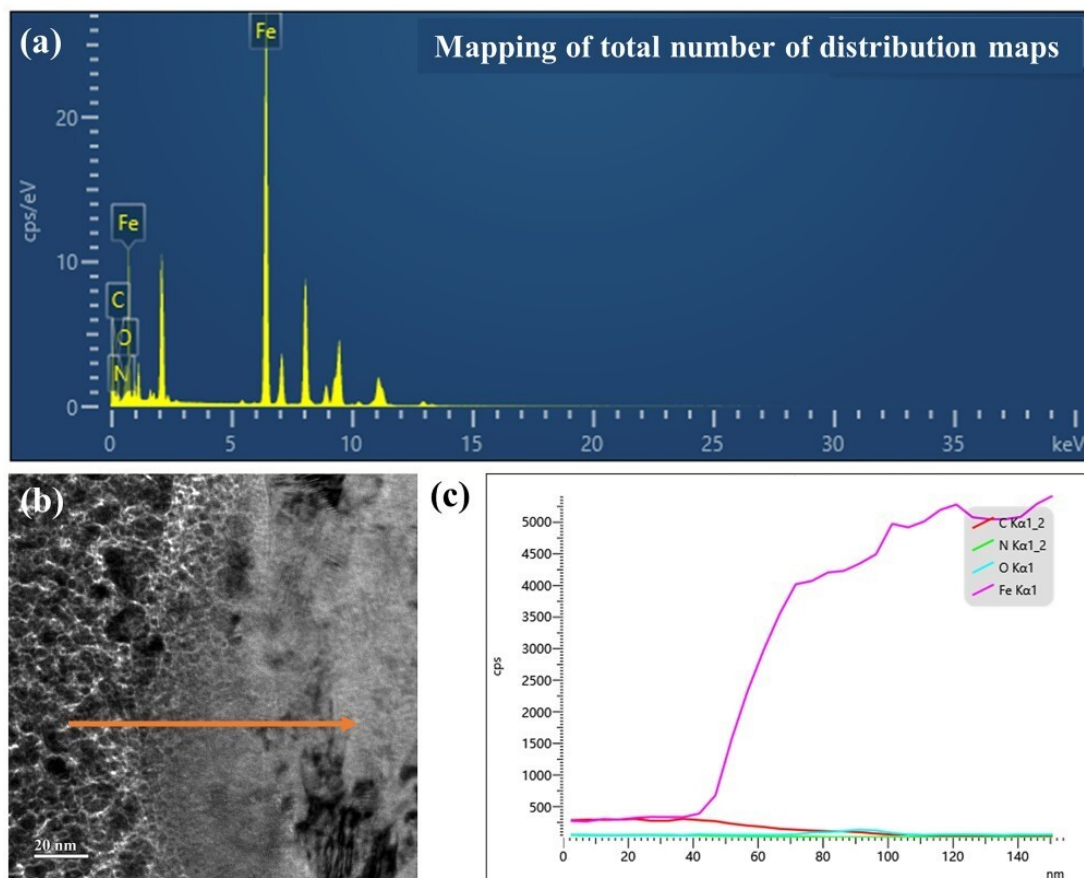
$$D = \frac{B}{T} \times \frac{O}{h} \times \frac{D}{O} \times 100 \% \quad (\text{S3})$$



**Figure S1:** Appearance of all prepared lubricants.



**Figure S2:** Optical images of cast iron sheets after immersed in different solutions at  $55 \pm 2$  °C for 24 hours.



**Figure S3:** (a) EDS results for region I in Fig. 14a, (b) location and direction of the linear scan (orange) for region II in Fig. 14a, (c) line scan results of C, N, O, Fe elements.

**Table S1:** Oxygen contents in closed bottles.

| Sample    | Initial O <sub>2</sub><br>(mg L <sup>-1</sup> ) | O <sub>2</sub> (mg L <sup>-1</sup> ) |           |           |           | Depletion of<br>dissolved O <sub>2</sub> (mg<br>L <sup>-1</sup> ) |
|-----------|---|--------------------------------------|-----------|-----------|-----------|---|
|           |   | 7 days                               | 14 days   | 21days    | 28 days   |   |
| Control   | 7.30±0.03                                       | 6.95±0.02                            | 6.75±0.03 | 6.69±0.04 | 6.59±0.04 | 0.71±0.07   |
| Reference | 7.30±0.03                                       | 4.38±0.02                            | 3.69±0.01 | 3.59±0.01 | 3.44±0.01 | 3.96±0.04   |
| EDG-LS    | 7.30±0.03                                       | 5.27±0.04                            | 4.89±0.02 | 4.74±0.02 | 4.37±0.01 | 2.93±0.04   |
| ODG-LS    | 7.30±0.03                                       | 4.74±0.03                            | 4.32±0.00 | 4.23±0.02 | 4.01±0.07 | 3.29±0.10   |

**Table S2:** Biodegradation rates of AAILs determined by the closed bottle test.

| Sample    | Biodegradability (%) |          |          |          |
|-----------|----------------------|----------|----------|----------|
|           | 7 days               | 14 days  | 21days   | 28 days  |
| Reference | 76.8±0.4             | 91.0±1.1 | 91.8±1.7 | 93.0±2.1 |
| EDG-LS    | 43.1±0.6             | 47.2±0.2 | 49.4±0.2 | 53.9±3.6 |
| ODG-LS    | 49.6±1.4             | 54.0±2.3 | 54.9±1.9 | 56.7±3.3 |