# Electronic Supplementary Information (ESI)

## $MoS_2$ nanoflower-decorated lignin nanoparticles for superior lubricant properties

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**Table S1.** FTIR spectra band assignment based on Faix (1991). [1]

| Wavenumber ($cm^{-1}$) | Band origin |
|---|---|
| 1510 | Aromatic skeletal vibration |
| 1460 | Methyl and Methylene C-H deformation |
| 1425 | Aromatic skeletal vibration, and C-H deformation |
| 1365 | Phenolic OH, and C-H in methyl group |
| 1265 | Guaiacyl ring, and C=O stretch |
| 1211 | C-C, C-O, and C=O stretch |
| 1145 | C=O in conjugated esters |
| 1124 | Aromatic C-H deformation, secondary alcohols, and C=O stretch |
| 1078 | C-O deformation in aliphatic ethers and secondary alcohols |
| 1030 | Aromatic C-H deformation, C-O deformation, and C=O stretch |

**Table S2**. XPS results from as received and sputtered $MoS_2$-HLNPs samples at different concentrations

| **XPS-Track** | **Atomic %** | **As received** | **Sputtered** | **As received** | **Sputtered** |
|---|---|---|---|---|---|
| Element | State | $MoS_2$-HLNPs 0.05 wt. % | | $MoS_2$-HLNPs 0.01 wt. %, *- traces | |
| S | Sum | 0.7 | 1.0 | 0.0* | 0.0* |
| | Sulphide | -- | 1.0 | -- | 0.0* |
| | Sulphate | 0.7 | -- | 0.0* | -- |
| Mo | oxide | 0.3 | 0.7 | 0.1 | 0.0 |
| C | Sum | 67.4 | 26.6 | 63.6 | 23.3 |
| | C-C | 37.7 | 17.3 | 33.2 | 14.2 |
| | C=C | 15.7 | 3.6 | 16.0 | 5.8 |
| | C=O | 7.2 | 2.5 | 6.1 | 1.4 |
| | carboxylic | 3.0 | 1.0 | 3.6 | 0.0 |
| | carbonate | 3.8 | 1.4 | 4.8 | 1.9 |

## References

1 Faix, O. "Classification of Lignins from Different Botanical Origins by FT-IR Spectroscopy" , vol. 45, no. s1, 1991, pp. 21-28. https://doi.org/10.1515/hfsg.1991.45.s1.21