Effect of lignin source and modification on lignin nanoparticle performance in applications

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Lignin is a natural biopolymer produced as byproduct of pulp and paper industry and cellulosic biorefineries. Technical lignins have heterogenic structure depending on their processing parameters and severity of treatment and often these lignins contain high amounts of impurities and suffer from low solubility which makes their valorization potential low. Hydrolysis have been introduced as a novel biorefinery concept, processing the lignocellulosic biomass with complete recovery of all biomass components, ultimately producing fractions of hydrolyzed sugars and lignin. The potential of these hydrolytic sulfur-free lignins especially for high value biomedical, cosmetic or coating applications is enormous but the low solubility of these still possesses a challenge.

The emerging trend in lignin valorization in the form of colloidal lignin particles (LNPs) show great potential.[1] LNPs offer a versatile platform for demanding applications due to their spherical geometry, well defined surface chemistry, high tunability of the surface functional groups, and large surface area. Their dispersibility in aqueous and hydrophilic media is a further asset. The mainstream process of obtaining homogeneous spherical LNPs relies on self-assembly of lignin in antisolvent. While the process is generic and suitable for many lignin sources, the yield and properties of the resulting LNPs are affected by factors such as source of lignin, solubility, molecular weight, solvent-lignin interaction, and solvent-water interaction.

In this work, we aim to test the suitability of hydrolytic lignins obtained from a novel biorefinery process for production of LNPs and applications thereof. We have characterized and fractionated different acid hydrolyzed lignins from softwood and hardwood origin and improved self-assembling methods for producing the LNPs. The results are compared with LNPs obtained from other commercial lignins. The characterization techniques included NMR, IR, GPC, AFM, SEM, zeta sizer, etc. We elaborate how simple changes in recovery of the lignin may enhance the LNP yield significantly. The performance of the LNPs in various applications, like Pickering emulsions and composites are described.

References:

1. Österberg, M., Sipponen, M. H., Mattos, B. D. & Rojas, O. J. Spherical lignin particles: a review on their sustainability and applications. *Green Chem.*, **2020**, 22, 2712–2733