Role of interfacial interactions in unlocking the full potential of plant-based nanomaterials

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Plant biomass-based nanoparticles, like nanocellulose and lignin nanoparticles, hold great potential for the development of lightweight, functional, biodegradable, and/or recyclable material solutions for a sustainable circular bioeconomy. However, to obtain optimal properties of the nanoparticles and materials made thereof, it is crucial to control the interactions both during particle production and in applications [1]. Herein we will focus on lignin, abundantly available as side streams from pulp industry and biorefineries, and nanoparticles made thereof (LNPs). Due to their nano-scale morphology and well-defined surface characteristics LNPs can introduce better processability, compatibility, functionality or stability compared to other forms of lignin. Furthermore, the spherical morphology and tunable size enable applications in totally new fields for example drug delivery or cosmetics [1]. However, owing to the heterogeneous and complex structure of lignin, its self-assembly mechanism and interactions remain unclear. In this presentation we will shed some light on these interactions and how they drive both the nanoparticle self-assembly as well as can be utilized in applications. Furthermore, we will show the synergistic effects of spherical LNPs and cellulose nanofibrils for emulsion stabilization and how this can be used to design strong, yet biodegradable composites [2] and biobased barriers [3]. We will also demonstrate how brown lignin can be turned into superhydrophilic, transparent colorless antifogging coatings by using modified LNPs [4] (Figure 1). These examples will reveal how controlling interfacial interactions enable attaining surface functionalities while retaining biodegradability and recyclability of the biobased materials. This approach contrasts with modifications depending on direct chemical modification or addition of synthetic materials.

Keywords:
lignin nanoparticles, Pickering emulsions, functional coatings

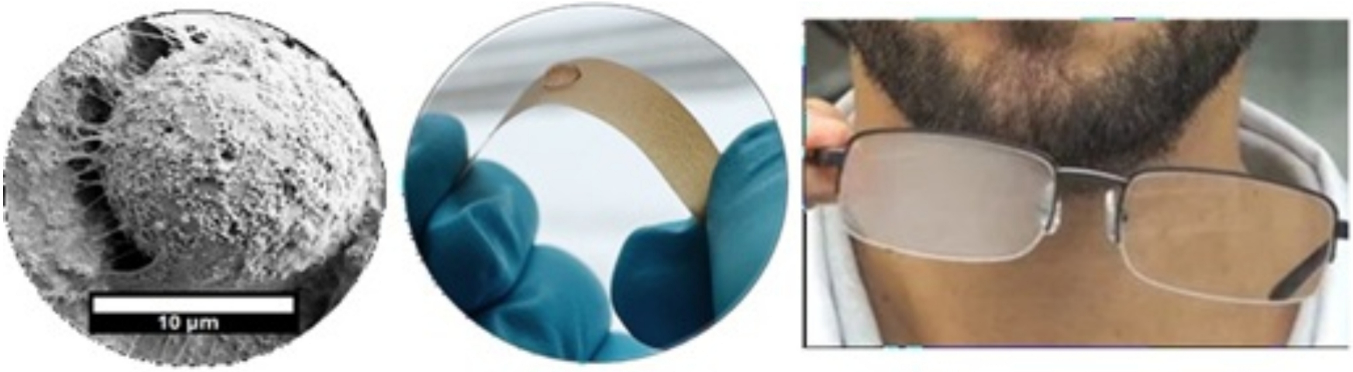

Fig.1 The figure shows application of LNPs; LNP and nanocellulose stabilized Pickering emulsion droplet, water resistant, yet biodegradable nanocomposite film and superhydrophilic antifogging coating.

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