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Biomimetic approaches for design of antimicrobial paper barrier coatings with hierarchical surface structure

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The design of functional paper coatings with excellent barrier properties towards water and oxygen ingress in parallel with enhanced recyclability of the coating layer is highly demanded, in view of sustainable applications for paper as a food packaging material in industrial context. Therefore, enhanced functionalities of the coating layers should be incorporated through a combination of selected bio-based materials and the creation of appropriate surface textures that enhance coating performance. The bio-inspired approaches through replication of hierarchical surface structures with multi-scale dimensional features in combination with selection of appropriate bio-based functional groups offer new concepts for coating design. In this overview, some of the recent advances in the field are illustrated with focus on the combination of hydrophobic and anti-microbial coating functionalities. Based on our long-term work with an available toolbox of bio-based building blocks and nanoscale architectures, they can be processed into applicable aqueous suspensions for paper coating deposition. The macroscopic roughness profile of paper substrates can be complemented through the decoration of nanoscale bio-based polymer particles of polyhydroxybutyrate or vegetable oil capsules with dimensions in the range of 20 to 50 nm, or 100 to 500 nm depending on the synthesis conditions. The anti-microbial properties can be provided by the surface modification of nanocellulose with biologically active molecules sourced from nature. Besides the more fundamental issues in design and synthesis, industrial application of the bio-inspired coatings under spray-coating application becomes relevant.