Bacterial Nanocellulose: Surface Microstructuration and Composites

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Cellulose is a non-toxic, degradable and almost inexhaustible biopolymer expected to play a strategic role in replacing petroleum-based polymers. Nanocelluloses are gathering growing interest because they combine the properties of the cellulose (hydrophilicity, semi-crystalline fibrous morphologies, broad chemical modification capacity,…) with the high surface area of nanomaterials. Although cellulose is primarily obtained from plants, it can also be synthesized by bacteria, algae and fungi (Figure 1). In particular, bacterial nanocellulose (BNC) produced by microbial fermentation has the same molecular formula as plant-derived cellulose but, in contrast, is a pure biopolymer that exhibits a high degree of polymerization and crystallinity. Other distinctive features of BNC are: i) this nanocellulose can be manufactured under laboratory and pilot-plants conditions, ii) the control of cellulose topography and morphology can be attained during biosynthesis or iii) unique features can be introduced by combining cellulose characteristics with nanomaterials properties [1]

We have exploited several of such features to create advanced functional materials. Firstly, a strategy to control morphology and surface structuration of BNC films during biosynthesis will be described. Large areas with good replication of the stamp topographies down to few micron sizes have been achieved. Secondly, we will show some original routes to afford functional BNC nanocomposites by anchoring inorganic nanocrystals on the cellulose fibers and assemble "millefeuille" layered constructs [2,3] (Figure 2).

Performance of these nanocomposites in photocatalytic reactions and as a transportable culture platform for adherent mammalian cells will be presented.

References

[1] Klemm et al. Angew. Chem. Int. Ed. (2011) 50, 5438-5466
[2] Zeng et al. Journal of Materials Chemistry C 2 (2014) 6312-6318
[3] Zeng et al. Cellulose (2014) 21 4455–4469

Figures

Figure 1: Sea squirt Ciona intestinalis, vase tunicate, with a cellulose exoskeleton.
S. Siebert, Science in School Issue 41(2017).

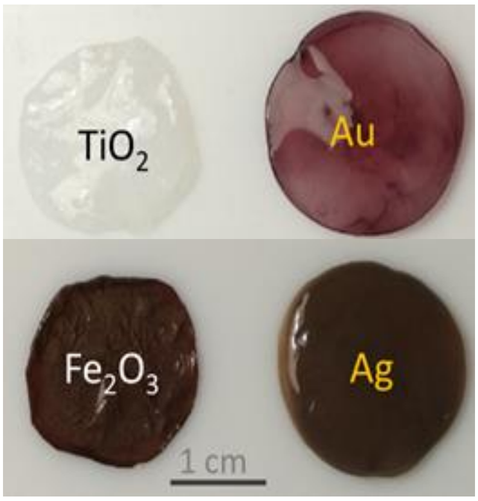

Figure 2: Bacterial nanocellulose composited with metal oxide and metal nanoparticles.