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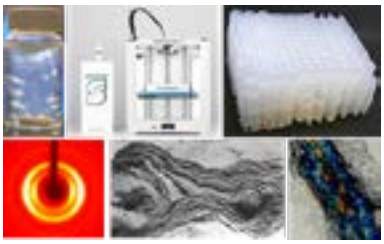
3D printed porous bioscaffolds based on cellulose nanocrystals

Sahar Sultan and **Aji P Mathew**
Stockholm University, Sweden

Nanocellulose extracted from natural resources are used extensively in biomedical field. They have properties of cellulose, such as potential for chemical modification, low toxicity, biocompatibility, biodegradability, low toxicity, high mechanical properties, renewability as well as nanoscale characteristics like high specific surface area, rheological and optical properties. Due to the inherent shear thinning property of nanocellulose, the 3-Dimensional (3D) printing technique has revolutionized the bioscaffolds with customization, complex geometries, controlled porosity, bioprinting and hierarchical features, in terms of composition and structural designs. Furthermore, during 3D printing the high aspect ratio of cellulose nanocrystals (CNCs) is expected to induce shear alignment yielding directionality in the 3D printed scaffolds. CNCs based double crosslinked interpenetrating polymer network (IPN) hydrogel has been made and 3D printed into 2D and 3D scaffolds with uniform and gradient porosity. The pore sizes are in the range of 80-2080 µm and 195-2382 µm in the wet and freeze-dried states respectively. These pores are distributed in a controlled manner that in turn provides gradation in density and porosity of the 3D printed hydrogel scaffolds. The directionality studies showed that CNCs tend to align parallel to the printing direction and degree of orientation varies between 61-76 %, depending on the point of measurement within the 3D printed scaffolds. In addition, this study also highlights the importance of nozzle movement during 3D printing to achieve scaffolds with better resolution, higher dimensions and good shape fidelity. The alignment of nanocrystals in this work yields directionality that can serve as an important step toward the development of tailored architectures. This study demonstrates the potential of 3D printing in developing bio-based scaffolds with controlled pore sizes, gradient pore structures and customized geometry for optimal tissue regeneration applications.



Recent Publications:

1. Sahar Sultan, Gilberto Siqueir, Tanja Zimmermann and Aji P Mathew (2017) 3D printing of nano-cellulosic biomaterials for medical applications. Current Opinion in Biomedical Engineering 2:29-34.
2. Sahar Sultan and Aji P Mathew (2018) 3D printed scaffolds with gradient porosity based on cellulose nanocrystal hydrogel Nanoscale 10:4421–4431.
3. Sahar Sultan, Hani Nasser Abdelhamid, Xiaodong Zou and Aji P Mathew (2019) CelloMOF: nanocellulose enabled 3D printing of metal–organic frameworks. Advanced Functional Material 29:1805372

Biography

Sahar Sultan is a third year PhD student in Stockholm University. She is actively working with 3D printing of cellulose nanoparticles. She has also served industry for 5 years by working as a researcher and safety officer in a solar cell company called Exeger Sweden AB.

sahar.sultan@mmk.su.se