3D PRINTING OF CELLULOSIC MATERIALS VIA DIRECT INK WRITING

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Three-dimensional hierarchical structures with controllable mechanical properties are expected to have wide range of applications. In general, material properties depend on the building block and it remains challenging to develop materials with dramatically different mechanical properties from the same type of material. In this presentation, cellulose was demonstrated for 3D printing of two types of structure. In one case, a lightweight (~90 mg/cm^3) and super-strong (16.6 MPa compressive Young's modulus) honeycomb structure is constructed by 3D printing of cellulose ink dissolved in NaOH/urea solution. The 3D printed cellulose structure demonstrated switchable high elasticity (to withstand varied repetitive elastic deformation) at the wet state and high rigidity (to support over 15,800 of its own weight) at dry state.[1] In another case, we demonstrated a compressible and superelastic 3D printed structure based on cellulose nanofibrils. The 3D structure showed superb elasticity (over 91% strain recovery after 500 cycles of compressive test) and compressibility (up to 90% compressive strain). In addition, with the incorporation of salt, the 3D printed CNF structure was demonstrated to serve as pressure sensor with high pressure sensitivity of 0.337 kPa^{-1} at 43% relative humidity.[2] These results indicate that the mechanical properties of the 3D printed cellulose structure can be facilely controlled by the inter-fibril interactions, leading to either super-strong or super-elastic materials properties.

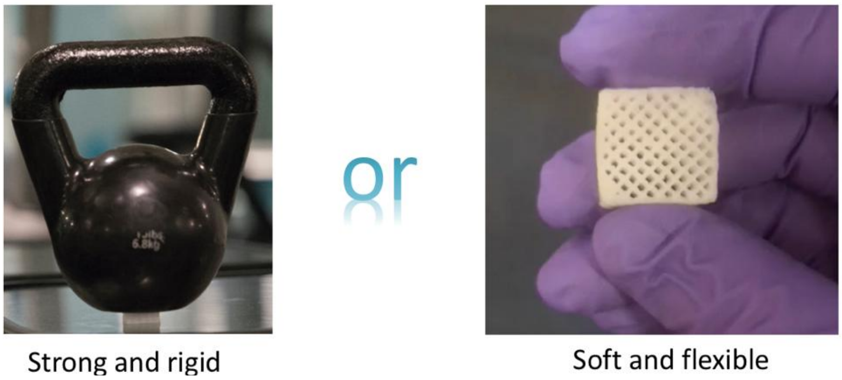

Fig. 1 *3D printed all-cellulose monolith showing either strong/rigid or soft/flexible properties*

References

1. Jiang, J.; Oguzlu, H.; Jiang, F., 3D printing of lightweight, super-strong yet flexible all-cellulose structure. *Chemical Engineering Journal* **2021,** *405*, 126668.
2. Chen, Y.; Yu, Z.; Ye, Y.; Zhang, Y.; Li, G.; Jiang, F., Superelastic, Hygroscopic, and Ionic Conducting Cellulose Nanofibril Monoliths by 3D Printing. *ACS Nano* **2021,** *15*, 1869-1879.