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Abstract

3D Printing of Granular Biocomposites

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Nature fabricates lightweight materials, such as the mussel byssus or bone, that display a fascinating combination of stiffness and strength. These excellent mechanical properties are a result of an intricate interplay between structural control over the nm up to the mm length scales and locally varying compositions. We are far from reaching a structural and compositional control that can span a similar range of length scales. As a result of the inferior structural and compositional control, most of the manmade polymer-based composites possess mechanical properties that are inferior to those of natural counterparts, especially if normalized by their densities.

Bioprinting offers a powerful method to replicate nature's complexity in synthetic hydrogels. However, rheological modifiers are often required to facilitate the 3D printing process due to the limitations of the rheological properties of single network hydrogel precursor solutions. To expand the range of printable precursor solutions, we introduce microgels, hydrogels formulated as microparticles, to enhance the 3D printability of natural polymer precursor solutions. We reinforce the 3D printed biopolymer-based hydrogels by introducing a secondary network to obtain double network granular hydrogels (DNGHs) [1]. The stiffness of DNGHs can be further increases if they are selectively reinforced with metal-ligand bonds.

In the second part of this talk, we will introduce a drop-based process to room temperature 3D print $CaCO_3$-based composites with $CaCO_3$ contents up to 93 wt%, which are much stiffer than the polymer-based composites. These composites display compressive strengths as high as 3.5 MPa. This is achieved by 3D printing bacteria-containing microgels into cm-sized self-supporting granular hydrogels that can subsequently be homogeneously mineralized [2].

AUTHOR'S STATEMENT

Conflict of interest: No conflict of interest to disclose. Animal models: No animal experiment model was used. Informed consent: Informed consent has been obtained from all individuals included in this study. Ethical approval: There is no ethical approval required in this experimental handling. Acknowledgments: NA

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