Tailoring Writability and Performance of Star Block Copolypeptides Hydrogels through Side-Chain Design

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What was achieved?:

The paper outlines the synthesis and characterization of shear-recoverable hydrogels, which are based on 3-arm star-shaped block copolypeptides. These copolypeptides consist of diverse side chains and block lengths, with an inner hydrophilic domain and outer domains facilitating β-sheet formation. The study elucidated structure-function relationships using scattering and rheological techniques, showcasing the versatility of block copolypeptide materials in achieving tunable properties, solely through molecular design. Such properties include thixotropy, yielding and recovery, which directly influence the printability and structural integrity of printed objects. Finally, the materials' printability using direct-ink writing (DIW) was explored, highlighting the correlations between material chemistry and printability.

Why is it important?:

This research is significant for additive manufacturing, as it offers a novel approach to creating shear-recoverable hydrogels without the need for additives. Traditional hydrogel materials often have limitations such as batch-to-batch variation and limited tunability. By utilizing block copolypeptide materials, which can be precisely synthesized with well-defined molecular weights and architectures, this study addresses these limitations. The ability to tailor hydrogel properties like thixotropy, yielding and recovery, solely through molecular design provides a robust platform for creating customizable materials for various applications, including biomedical engineering, electronics, and structural materials. These findings provide a basis to rationally design the 3D-printability and performance of sustainable, biocompatible polymers using amino-acid building blocks in tunable hydrogels.

How is this achievement synergistic with BioPACIFIC MIP?

The researchers utilized the Small-Angle X-ray Scattering (SAXS) facility to analyze the spacing of β-sheets, providing insights into the structure-property relationship of the hydrogels. Furthermore, the printability of the hydrogels was evaluated utilizing both the additive manufacturing facility and the expertise of BioPACIFIC MIP project scientist Juan Manuel Urueña. Ronnie Garcia received partial support from the Fellows program to conduct this research.

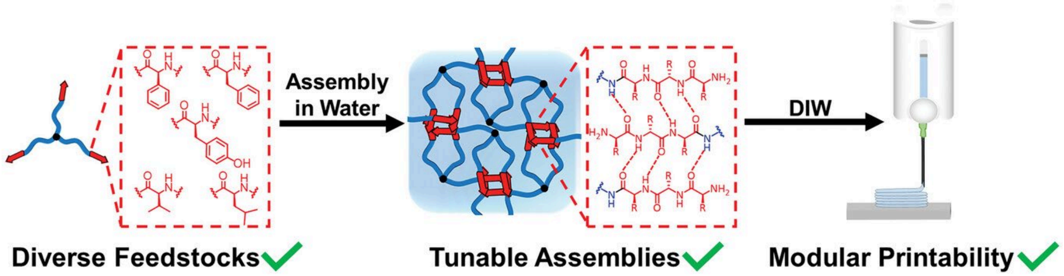

Figure 1: *Modular design of 3-arm block copolypeptide enables tunable microstructure and properties based on amino acid selection.*

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