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Injectable Shear-thinning and Self-Healing Hydrogels for Tissue Repair and Biofabrication Applications

Hydrogels represent a class of biomaterials that have great promise for the repair of tissues, particularly due to our ability to engineer their biophysical and biochemical properties. Hydrogels can provide instructive signals through material properties alone (e.g., mechanics, degradation, structure) or through the delivery of therapeutics that can influence tissue morphogenesis and repair. Here, I will give examples of the design of hydrogels based on hyaluronic acid (HA) for use as injectable therapeutics or towards 3D bioprinting applications. Towards cardiac repair, my laboratory is interested in designing materials that can influence the left ventricular remodeling process that occurs after myocardial infarction. To permit percutaneous delivery of hydrogels (e.g., via catheters), we have developed a class of shear-thinning and self-assembling hydrogels that can be used for the delivery of mechanical signals, as well as cells and therapeutics (e.g., protease inhibitors). These hydrogels assemble based on guest-host interactions and can be designed to degrade via matrix metalloproteinases or to become more stable through secondary crosslinking. These iterations on material design are teaching us what important signals are needed in these hydrogels towards the next generation of translatable therapeutics for cardiac repair. Beyond injectability, these hydrogels are also useful for bioprinting in the area of additive manufacturing. Our approach involves the printing of a shear-thinning and self-healing hydrogel ink into another support hydrogel in 3D space. Shear forces disrupt the hydrogel structure for extrusion and also to receive the extruded material, with resolutions dependent on needle diameter, printing speed, and extrusion rate. This approach allows for the printing of cells, multiple inks into the support gel, and pockets of materials. Additionally, open and perfusable structures (e.g., channels) can be fabricated with secondary photocrosslinking of the support hydrogel and washing of the ink.

Bio:

Jason A. Burdick, PhD is a Professor of Bioengineering at the University of Pennsylvania. Dr. Burdick's research involves the development of hydrogels for various biological applications and his laboratory is specifically interested in understanding and controlling polymers on a molecular level to control overall macroscopic properties. The applications of his research range from controlling stem cell differentiation through material cues to fabricating scaffolding for regenerative medicine and tissue repair. Jason currently has over 200 peer-reviewed publications and has been awarded a K22 Scholar Development and Career Transition Award through the National Institutes of Health, an Early Career Award through the Coulter Foundation, a National Science Foundation CAREER award, a Packard Fellowship in Science and Engineering, and an American Heart Association Established Investigator Award. He is on the editorial boards of *Tissue Engineering*, *Biomacromolecules*, *Biofabrication*, and *Journal of Biomedical Materials Research A*, and is an Associate Editor for *ACS Biomaterials Science & Engineering*.