Cyber-Enabled Online Quality Assurance for Scalable Additive Bio-Manufacturing (Bio-AM)

Zhenyu (James) Kong[1], Blake N. Johnson[1], Haibo Zeng[2], and Prahalad Rao[3]

[1]Virginia Tech, Department of Industrial and Systems Engineering
[2]Virginia Tech, Department of Electrical Engineering
[3]University of Nebraska - Lincoln, Department of Mechanical and Materials Engineering

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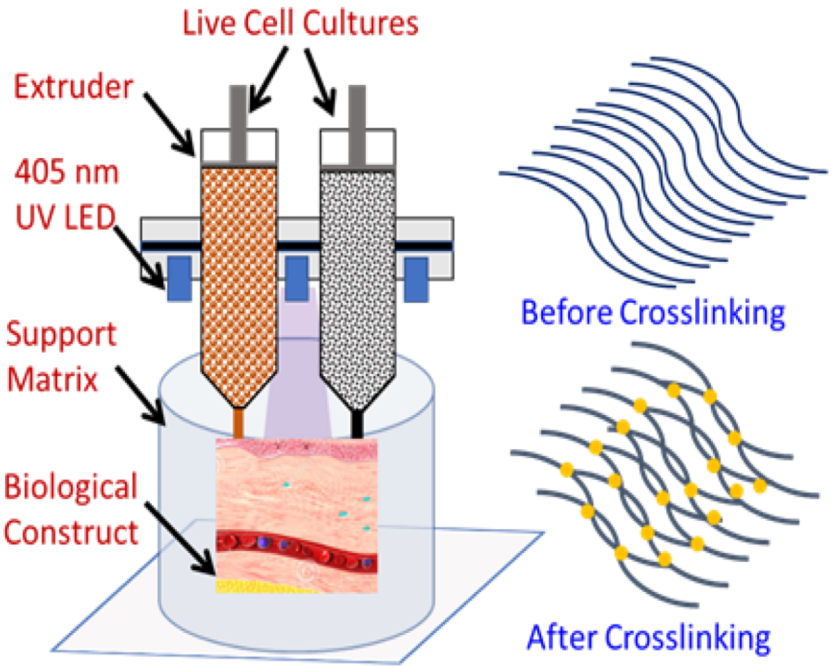
Description

Goal:

To realize high quality and reproducible 3D printing of mini-tissues, and thus transform Bio-AM from the prototype-demonstrator status to production-scale.

Objectives:

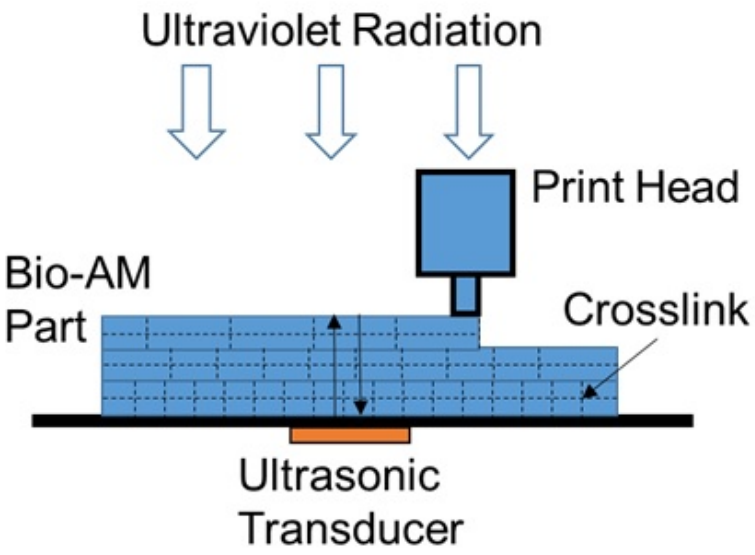
- Understanding the causal effect of process-material interactions on specific Bio-AM defects with experimentation and modeling.
- Detecting incipient process defects during printing using heterogeneous sensors.
- Diagnosing the root cause of the detected defect and preventing further propagation of a defect through closed-loop process control.



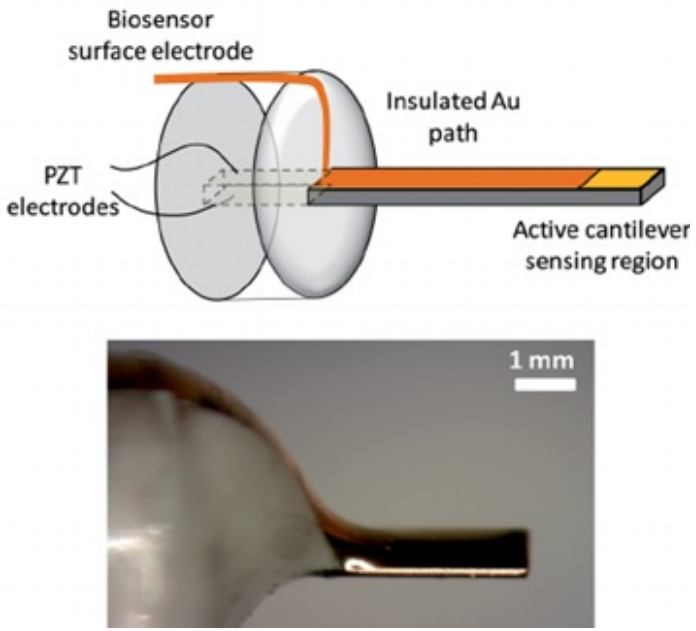
The concept of Bio-AM through a sensor-integrated micro-extrusion bioprinting process.

Findings

- Millimeter cantilever sensors provide multiple online signals associated with the bio-printed constructs viscoelastic properties.
- Sensors can facilitate online monitoring of UV curing in bio-printed hydrogels.
- Sensor data correlates with *quality* measures acquired using offline measurements carried out using standard characterization instrumentation.

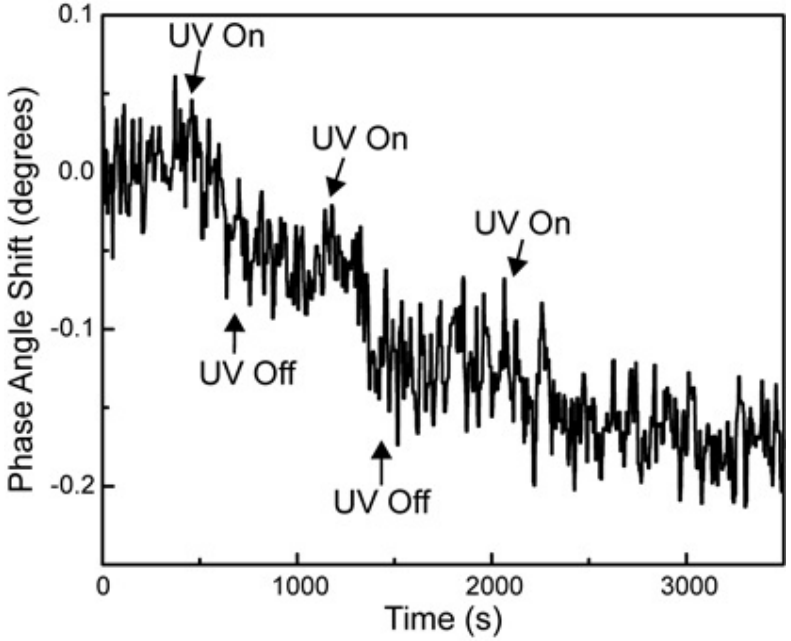


Schematic of online viscoelastic property sensing using an ultrasonic cantilever transducer.

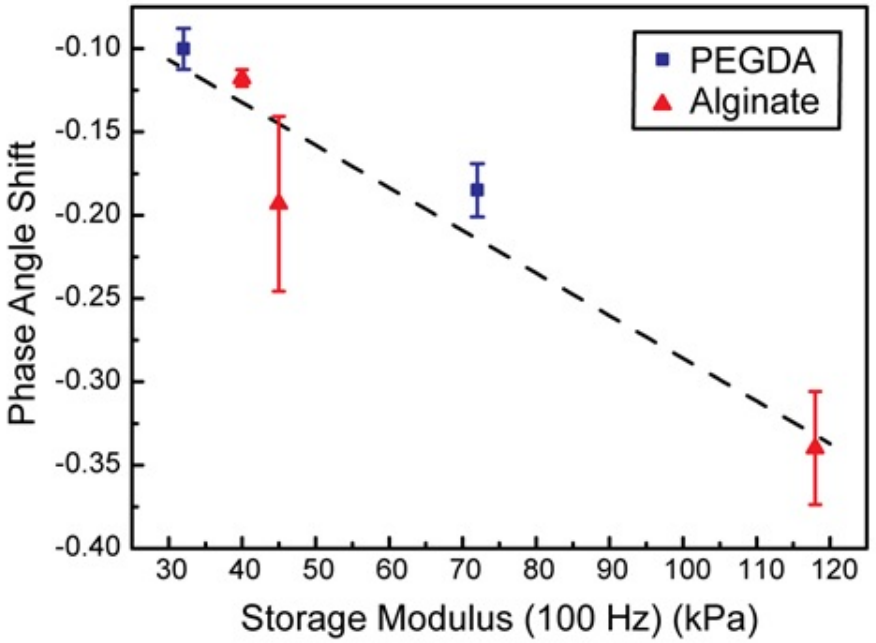


Schematic and photograph of a piezoelectric-excited millimeter cantilever (PEMC) sensor.

Findings (contd.)



Continuous monitoring of bioink photocuring (i.e., gelation/ solidification) in a pulsed mode.



Correlation between net sensor shift (online signature) and offline quality measure.