Bioinspired polymer processing: how improved control over biomaterial structure-function can facilitate translation.

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Abstract:
Bioinspired polymer processing, with focus on improved control over biomaterial structure-function, is a research strategy that can play a critical role in facilitating the translation of a biomedical device. This seminar utilizes the specific example of tissue engineered heart valves to demonstrate this notion.

Valvular heart disease is currently treated with mechanical valves, which benefit from longevity, but are burdened by chronic anticoagulation therapy, or with bioprosthetic valves, which have reduced thromboembolic risk, but limited durability. Tissue engineered heart valves (TEHV) have been proposed to resolve these issues by implanting a scaffold that is replaced by endogenous growth, leaving autologous, functional leaflets that would putatively eliminate the need for anticoagulation and avoid calcification. Despite the diversity in scaffold fabrication strategies and encouraging results in large animal models, control over engineered valve structure-function remains at best partial. Human heart valve tissue structure-function is still inadequately characterized. While the notion of bioinspired control of structure and function is recognized as a promising strategy to enhance TEHV performance, the approach remains relatively unexplored *in vivo.*

This study faces these challenges by introducing double component deposition (DCD), a novel polymer electrodeposition technique that employs multi-phase electrodes to dictate valve macro and microstructure and resultant function. Engineered valve *in vitro* characterization included: leaflet thickness, biaxial properties, bending properties, and quantitative structural analysis of scanning electron micrographs. Results demonstrated the capacity of the DCD method to simultaneously control scaffold macro-scale morphology, mechanics and microstructure while producing fully assembled multi-leaflet valves composed of microscopic fibers. The efficacy of this technology was further assessed *in vivo* in an acute porcine model with the evaluation of three different devices: stented pulmonary valve, stentless tricuspid valve and stentless mitral valve. Results confirmed the potential of DCD processed valves to be translated to the bedside, reducing patients' mortality.

A general overview of the RiMED Tissue Engineering Program will be provided at the end of the seminar.