In the US alone, roughly 1.4 million patients undergo operations requiring arterial prostheses annually. Tissue engineering represents a potential means to construct functional small diameter vascular grafts in situations where autologous tissue is unavailable and conventional synthetic materials fail. While initial results with many of the tissue engineered vascular grafts (TEVGs) constructed to date are very encouraging, the potential for thrombosis, hyperplasia, and mechanical failure has limited their success. The relatively poor mechanical properties of TEVGs are believed to result primarily from insufficient extracellular matrix (ECM) deposition by and the inappropriate phenotype of associated smooth muscle cells (SMC).

In the present study, we characterize the effects of novel inorganic-organic hydrogel scaffolds generated by the photo-cure of hydrophobic star polydimethylsiloxane ($PDMS_{star}$) (inorganic polymer) and hydrophilic linear poly(ethylene oxide) (PEO) on SM progenitor cell differentiation and ECM production. Initial studies have shown these hybrid scaffolds to be biocompatible, non-thrombogenic, and highly elastic. In addition, they display unique microstructural, biochemical, and biomechanical properties that can be precisely tuned over a broad range, enabling systematic exploration of the effects of scaffold material properties on cell behavior.

Twelve hydrogel $PDMS_{star}$-PEO hydrogel formulations were prepared by varying the MW of the $PDMS_{star}$ arms and the weight ratio of $PDMS_{star}$ to PEO, resulting in scaffolds covering a broad range of initial microstructures, hydrophobicities, and mechanical properties. These alterations in materials properties had a significant impact on cellular differentiation and ECM production. Specifically, progenitor cells demonstrated increasing levels of differentiation with increased scaffold hydrophilicility and decreasing scaffold modulus. Similarly, the levels of collagen and elastin production varied significantly with hydrogel $PDMS_{star}$ concentration. From these results, we have identified a material property range which appears to evoke both high ECM deposition and SMC differentiation toward TEVG optimization.