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Synthetic PEG hydrogel enabling technologies for the neovascularization of engineered tissues

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The ability to induce rapid and stable neovascularization in engineered tissues remains a critical obstacle to successful regeneration. Stimulation of neovascularization in scaffolds is highly dependent upon precise control of spatiotemporal presentation of extracellular matrix (ECM) signals as well as the physical and mechanical properties of the biomaterial. To this end we have developed and present novel and biomaterial approaches for the development of poly(ethylene glycol diacrylate (PEGDA) hydrogel scaffolds formed using free-radical photopolymerization with (1) enhanced proteolytic degradation independent of variations in modulus, (2) tunable gradients of immobilized ECM signals, degradation, and modulus and (3) controlled porosity for rapid neovascularization.

Controlled scaffold degradation was engineered in hydrogels by varying the numbers of matrix metalloproteinase (MMP)-sensitive peptides between crosslinks. MMP-sensitive macromers containing one (SSite) or multiple (MSite) domains were crosslinked into hydrogels. SSite and MSite hydrogels resulted in similar modulus, but in statistically different degradation times of 2-4 days and 1-3 hours, respectively. MSite gels exhibit enhanced in vitro vessel invasion areas by 7 fold and invasion depth by 2 fold compared to SSite gels with neovascularization occurring over a wider modulus range in MSite gels. Additionally, we have generated PEG hydrogels with tunable gradients of cell adhesion ligands, degradation, and modulus that result in 3D bidirectional sprout formation with sprout length spanning over 2000 μm in length. Finally, porosity in MMP-sensitive PEG hydrogels was incorporated using gelatin beads as the porogen. Porosity and pore diameter are tuned with changes in bead diameter and porogen loading which directly influence neovascularization.

Biography

Georgia Papavasiliou completed Ph.D. degree in Chemical Engineering from the Illinois Institute of Technology (IIT) and postdoctoral studies at Johnson Polymer focusing on modeling kinetics of gelation. She is currently an assistant Professor in Biomedical Engineering at IIT where she is the director of the Polymer Tissue Engineering Laboratory. She has published 13 papers in reputed journals in research focusing on computational and experimental control of gelation and hydrogel scaffold design.

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