UV-Crosslinking Poly(vinyl alcohol)-Methacrylate for Complex Brain Aneurysms

Lee, Rachel (School: Palos Verdes Peninsula High School)

Understanding complex brain aneurysm geometry through detailed modeling for aneurysm behavior comprehension facilitates the prevention of focal dilation rupture in cerebral vasculature linked to hemorrhagic stroke and death. However, excessive rigidity, time-consumption, inconsistency, and environmental concerns mark traditional chemical crosslinking as an increasingly disadvantageous approach to aneurysm modeling. This study presents novel UV-crosslinking with poly(vinyl alcohol)-methacrylate (PVA-MA) to heighten crosslinking quality for improved treatment outcomes. PVA was synthesized with IEMA to form PVA-MA, and the resulting polymer was dissolved in distilled water to create aqueous hydrogels at 10-20wt%. PVA-MA crosslinked under UV light with photoinitiators Irgacure651, Irgacure2959, and LAP to validate digital light processing 3D-printing techniques for aneurysm modeling. The PVA-MA samples were investigated in aqueous medium and characterized by NMR and IR spectroscopy. The shear modulus of resulting 3D gel disk samples evaluated durability. The function and stability of UV-crosslinked samples proved to be more reliable in comparison to chemical crosslinking, marked by a notable 2-3× reduction in rigidity with a 12× increase in crosslinking efficiency. Additionally, rheological studies demonstrate that higher concentrations of PVA-MA in distilled water by wt% correlate to greater effective shear modulus. By encompassing the main parameters of optimized shear modulus, efficiency, consistency, and sustainability, this study validates UV-crosslinking of poly(vinyl alcohol)-methacrylate as a compelling, revolutionary approach to accessible 3D-printing-based construction of brain aneurysm models and the subsequent development of enhanced treatment.

Awards Won: