

Abstract



Dr. LaShanda Korley

Distinguished Associate Professor
Department of Materials Science and Engineering
College of Engineering
University of Delaware

Title: Utilizing concepts of mechanics, transport, and assembly in Nature – towards responsive materials via strategic control of architecture and alignment

Taking cues from biological materials, we are interested in understanding the design rules employed by nature and applying these strategies to the development of mechanically-enhanced and tunable materials.

Motivated by the pine cone, we have explored the fabrication of responsive composite systems utilizing high modulus, electrospun and low molecular gelators as fillers. Here, we discuss new insights into hygromorphic (e.g. hydration/humidity) response in composites utilizing concepts of interfacial assembly, transport, bias, and orientation. We have fabricated a strategically interfaced hygromorphic composite utilizing an active electrospun filler and a passive, low molecular weight gelator layer in an elastomeric matrix. The impact of material parameters on water front progression and actuation were probed theoretically and

experimentally in their design. Via this approach, preferential coiling was observed, although two challenges were encountered due to the isotropic nature of the PVA mat: (1) slow response times, and (2) non-uniformity in hydration-induced response. To overcome these challenges, we explored the impact of the alignment of the PVA electrospun fibers as a handle to control rate of hydration and program shape change. These engineered hygromorphic composites exhibited predictable curvature, and much faster response times (2 - 3 min). It is anticipated that these water-responsive systems may have unique applications in therapeutic delivery and chemical/biological protection.

Inspired by spider silk, we have designed a series of polymer-peptide polyurethane/ureas to explore the hierarchical arrangement critical to energy absorption and mechanical enhancement. We have developed chain-extended and non-chain extended peptide-polyurea hybrids with tunable secondary structure, modulating extensibility, toughness, and stiffness. The sheet-dominant hybrid materials were typically tougher and more elastic due to intermolecular H-bonding, while the helical-prevalent systems generally exhibited higher modulus. We have also explored the impact of a molecular design strategy that overlays a covalent and physically crosslinked architecture in these hybrids, demonstrating that physical constraints in the network hybrids influences hydrogen bonding and morphology. More recently, tailored physical associations within the soft and hard phases were engineered as a function of peptide content, leading to a rheological response dictated by block ordering and highlighting their potential as structural and injectable hydrogels. These structural features have enabled new thrusts in injectable gels and responsive actuators.