Richard Vendamme et al., J Material Sci Eng 2017, 6:4(Suppl)
DOI: 10.4172/2169-0022-C1-067

Sticky degradable bioelastomers

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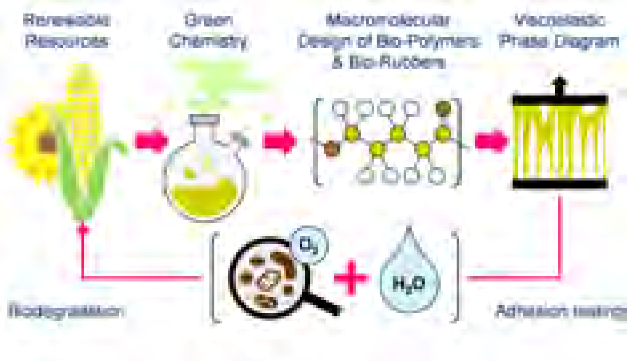
The biological function of natural soft biomaterials is often related to their unique biomechanical properties. For instance, sandcastle worms produce viscous hydrophobic secretions that strongly stick underwater, the adhesiveness of the glue droplets produced by orb-weaving spiders for coating their silk can be explained by the theory of viscoelastic solid, whereas the wing supports of beetles are mechanically very similar to man-made car tires. Synthetic soft biomaterials that mimic some of the elaborated features observed in Nature are attracting the attention of (bio)chemical engineers due to their promising applications in industry, biotechnology and medicine. Among the various classes of materials that have been used to synthesize such substances, polyesters have recently emerged as a versatile and sustainable platform for various reasons (solvent-free synthesis, biodegradability, etc.). In this paper, we investigate the important and often overlooked structure-property relationships underlying the complex viscoelastic and adhesion behaviors of soft polyester elastomers, an emerging class of degradable functional biomaterials and demonstrate that the adhesiveness of these materials can be mainly understood in terms of bulk viscoelastic factors, in contrast to alternative ideas reported in the literature. To that end, we designed a family of poly(isosorbide fatty alkylates) with different molecular architectures and physical aspects (viscous, sticky, rubbery and solid) as model polyester elastomers. Mechanical properties at both small and large strains and adhesion performances have been investigated by various techniques and complemented with theoretical frameworks resulting in the establishment of a new viscoelastic phase diagram depicting generic adhesive archetypes. These results shed some light on the intimate structure of bioelastomers, and notably on the decisive role of a well-adjusted macroscopic cluster of percolated polyester chains for tailoring key biomaterial functions such as elasticity, stickiness, fibrillation and biodegradation. By establishing a bridge between polyester biomaterials and the material science of sticky things, this paper provides robust design principles for diverse functional biomaterials with tailored dissipative characters such as adhesives with tuneable stickiness and degradation profiles, or scaffolds mimicking the non-linear elasticity of soft biological tissues.



Biography

Richard Vendamme obtained an Engineering degree and a Master's degree in Organic and Macromolecular Chemistry (France) in 2001. He subsequently moved to the Max-Planck Institute for Polymer Research (Mainz, Germany) for pursuing PhD dealing with stimuli-responsive liquid crystalline gels. In 2004, he was awarded a JSPS Post-doctoral Fellowship and started his career at the Institute of Physical and Chemical Research (RIKEN) in Japan, where he notably created a unique class of free-standing nanomembranes. He joined Nitto Denko in late 2007, where his interests extended to various topics such as molecular imprinting, adhesion, green chemistry, sustainability, bio-inspired materials, new business development and the translation of scientific innovations into real-life business cases.

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