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Hybrid Organic-Inorganic Biomaterials with Self-Healing Properties

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ABSTRACT: In some biomaterial applications there is a need for the devices to withstand cyclic loading. A recent discovery of a self-healing hybrid system with interpenetrating-networks of organic and inorganic components is investigated further in this work, as there is a need to better understand their structure-mechanical property relations. Specifically, we report on a series of silica-poly(tetrahydropyran)-poly(ε-caprolactone) (SiO_2-PTHP-PCL-diCOOH) materials, which are prepared through a three-step synthesis, including *in situ* cationic ring-opening polymerization, sol-gel reaction, and polymer-silica condensation. We use THP as the main constituent of the organic phase, which can be polymerized under mild conditions. Additionally, we control the degree of silica-crosslinking and the organic-inorganic ratio. The thermal stability, density as well as Young's modulus could also be regulated through such control. Of particular interest, the hybrid materials with certain organic polymer content above 73% show apparent self-healing ability, likely due to the reversible intermolecular forces and hydrogen bonding among the polymer chains. Finally, we discover that the PTHP-SiO_2 networks are stable in bio-like circumstances although PCL undergoes biodegradation. The present structural control approach could lead to the design of tailored functional hybrids, with potential applications within soft robotics and bone regeneration.

Reference: Fan W., Youngman R. E., Ren X., Yu D., Smedskjaer M. M. Structural Control of Self-Healing Silica-Poly(Tetrahydropyran)-Poly(ε-caprolactone) Hybrids. *Journal of Materials Chemistry B* **9**, 4400-4410 (2021).