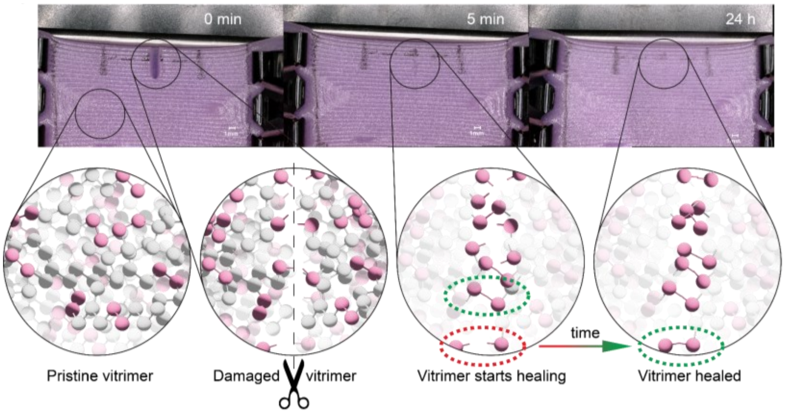
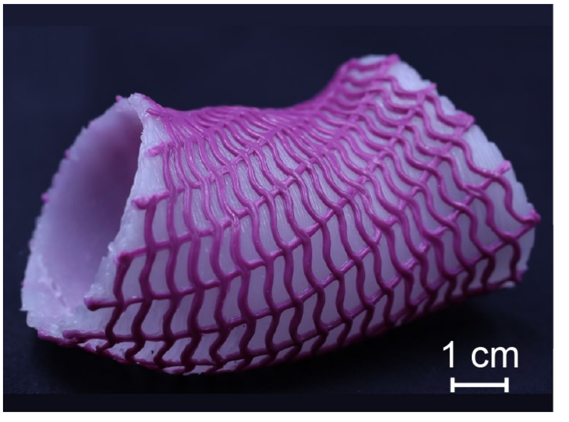
ETH zürich

Licensing Opportunity

Self-healing, 3D printable silicone formulation





Left: Self-healing of the 3D-printed silicone after being cut with a blade. Dynamic covalent bonds enable exchange reactions between crosslinks at the cut surfaces, leading to autonomic self-healing. Right: 3D-printed phantom of a human aortic arch.

Application

Self-healing and creep-resistant silicones can be employed in surgical phantoms, soft robotic actuators, and hydraulic tubings to enhance their durability and reduce human intervention in repairing mechanical damages. Moreover, the processability at room temperature enables the manufacture of complex-shaped parts with spatially tuned mechanical properties, which can significantly improve the performance of stretchable electronics.

Features & Benefits

- Simple, upscalable elastomer synthesis
- Fast self-healing at room temperature (< 24 h)
- High creep resistance
- Reprocessability without impairing mechanical properties

Publication

- “3D-Printed Architectured Silicones with Autonomic Self-Healing and Creep-Resistant Behavior”, Adv. Mater. 2024, 2306494 (10.1002/adma.202306494)
- Patent pending

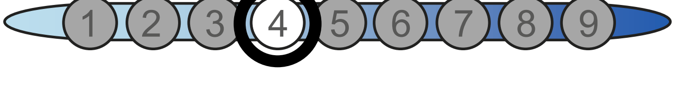
transfer

ETH transfer
transfer@sl.ethz.ch
www.ethz.ch/transfer
Reference 2023-089

Invented by D-MATL

F. Coulter, R. Nicolosi Libanori, S. Menasce, A. Studart

Technology Readiness Level



Background

Self-healing polymers are attractive materials because of their ability to recover structure and properties after physical damage, thereby enhancing the lifetime of functional devices. Several systems have been exploited, e.g. dynamically crosslinked rubbers and elastomers. However, these typically exhibit a trade-off between self-healing capabilities and mechanical performance. While introducing dynamic covalent bonds within the crosslinked network may lead to self-healing at room temperature, it often comes at the cost of mechanical strength and creep resistance. This strongly restricts practical applications requiring mechanical performance.

Invention

Silicone vitrimers and elastomers are combined in a multimaterial printing process to generate architectured silicones showing both creep-resistance and autonomic self-healing. These antagonistic properties are designed individually at molecular scale using specific functional monomers during polymer synthesis and are reconciled in a single object by designing a bespoke, multimaterial layered architecture at a coarser length scale. Self-healing is introduced by incorporating dynamic covalent groups in the chain extenders, whereas elasticity and resistance to creep result from the combination of chemically compatible silicone elastomers with permanent covalent bonds. Stiff, strong, and creep-resistant architectured silicones are obtained by 3D printing resins which are consolidated with a photopolymerization process. The mechanical properties of the self-healing silicones can be adjusted over a broad range by simply changing irradiation conditions during the photopolymerization process. Self-healing silicones with different mechanical properties can be easily combined into multi-material parts with complex geometries by cold welding.