Self-healing soft pneumatic robots

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Inspired by the soft tissue from which humans and many other organisms are made, soft robots are constructed from flexible materials. Their flexibility allows soft robots to be used for countless applications. They are used to grab delicate and soft objects in the food industry or in minimally invasive surgery. They also play an important role in rehabilitation and arm prostheses. Being made from soft materials, soft robots can perform tasks in dynamic work environments while ensuring safe contact with humans. However, the soft materials also make them susceptible to damage caused by sharp objects or excessive pressure. Damaged components must be replaced to avoid the robot ending up on the scrap heap.

Through a collaboration between the Physical Chemistry and Polymer Science (FYSC) research group and the Robotics & Multibody Mechanics (R&MM) research group, soft robots have been developed that can heal completely from such damage. These soft robots are constructed completely from rubbery polymers with built-in healing capacity. When damaged, these materials first recover their original shape and then heal completely. The polymers consist of a thermo-reversible covalent network, as a result of the Diels-Alder bonds that act as reversible cross-links. When heated microscopic and macroscopic damages, like cuts and punctures, can be healed entirely. This principle was applied in three self-healing robotic components: a gripper, a robotic hand, and an artificial muscle. These resilient, pneumatic components were damaged under controlled conditions, to test whether the scientific principle also works in practice. The results were most satisfactory: realistic damage could be healed completely without leaving any weak spots. After healing, the prototypes were able to fully resume their tasks. Using this new approach, in the future robots can not only be made lighter and safer, they will also be able to work longer independently without requiring constant repairs

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