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Editorial corner – a personal view
The way to autonomic self-healing polymers and composites

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Low-velocity impacts on fibre reinforced polymer composites may cause irreversible damages such as surface scratches, micro cracks or small internal flaws that can seriously impair the load carrying ability of structural components. In fact, these cracks can grow under subcritical loading conditions (such as fatigue or creep) and ultimately lead to failure. Repairing these small damages is often a difficult task since it requires non-destructive inspections an intervention under maintenance procedures. A big challenge for polymer scientists and engineers is to develop new polymeric matrices having the built-in ability to partially repair damages occurring during its service life time. An ideal self-healing polymer is able, after having been damaged, to autonomously restore its initial mechanical performances without the need of external stimuli like temperature, radiation, pressure, etc. This process is quite common in nature, since damage to a living tissue generally elicits a healing response.

Self-healing applied to thermosetting matrices and composites is an emerging area of research, with the first significant papers being published in early 2000's and with the 1st International Conference on Self-Healing Materials organized by the Delft University of Technology (NL) in 2007. The first report of a man-made self healing polymer was by the group of prof Scott White of the University of Illinois at Urbana-Champaign. They developed an epoxy system containing microcapsules filled with a healing agent (liquid monomer). When a crack propagates, the microcapsule will rupture, the monomer will fill the crack and eventually undergo a polymerisation process, initiated by (Grubbs') catalyst particles dispersed in the system. This model system proved to work quite well, as the service life time of such material under fatigue conditions is significantly improved. On the other hand, it also presents a number of drawbacks related to the Grubbs' catalyst (high cost, partial deactivation by the amine curing agent, decomposition above 120°C) and to the stability of the microcapsules (diffusion and leakage of the healing agent, decomposition of the capsules above 170°C). A number of research groups world wide is trying to improve the microencapsulation-based approach or to develop new approaches to self-healing. A possible alternative strategy is based on the development of reversible crosslinked polymers through self-assembly chemistry in which the material is repaired by the re-association of the self-assemblable bonds broken by the crack.

At a present, there are no commercially available products having a self-healing ability and the challenge for materials scientists and engineers is fascinating.

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