VASCULAR NETWORKS IN POLYMERS FOR SELF-HEALING

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Recent studies [1] on the introduction of the self-healing response to mechanical damage in polymeric materials constitute a new perspective in the investigation of soft condensed matter systems. The existing self-healing concepts, based on an encapsulated healing agent and catalyst particles in a polymer matrix, although efficient, do not allow for multiple healing. Inspired by the blood vessel networks in living organisms, we aim to develop a model polymeric system comprising of networks of micro- or nanochannels filled with a liquid self-healing agent. The continuous network, at least locally, throughout the material guarantees the supply of healing agent, even if multiple cracks appear (Fig. 1).

Figure 1: Schematic representation of structures (grey) embedded in the matrix (white): (a) Spherical particles, channels with a reservoir attached, a network of channels, and (b) hierarchical fractal-like network of channels. The cracks (black lines) have a low probability to hit spherical particles, a higher probability to hit a channel and a very high chance to hit one of the networks.

In this work, we explore several approaches towards the construction of the channel networks: (a) by means of fractal nanoparticle aggregates spread in a polymer matrix and subsequently dissolved by a suitable solvent; (b) by templates of nanoparticle agglomerates coated with a polymer and dissolved to leave empty shells, later to be filled with healing agent; (c) by formation of a interpenetrating polymer blend and removal of one of the components; (d) by using a block copolymer, forming continuous mesophase, with one of the blocks to be subsequently removed.

The resulting nonporous materials will be swollen with healing agent and studied in terms of fractal dimensionality (scattering methods) and mechanical properties (tensile test). Finally, the findings will be placed in the framework of the self-healing action and the applicability of the system will be discussed.

REFERENCES