

Self-healing polymers

Improving efficiency and reducing maintenance costs is very appealing for any manufacturer. A newer class of structural polymers with self-healing effect might help in achieving those goals. Self-healing polymers is a group of diverse materials with rather different properties that appear as both polymeric materials and polymer based composites.

When a load is applied to a material, especially dynamic or impact load, a crack can form within a structure where detection is difficult and repair can even be impossible. Microcracking can also be thermally induced. Cracking leads not only to mechanical and acoustical degradation but in the case of microelectronic polymeric components it can lead to electrical failure.

Polymers with self-healing properties may have a possibility to heal intrinsically and extrinsically. For the latter pre-embedded healing agents in the form of micropipes and microcapsules are needed. A catalyst is usually mixed into the base matrix. While extrinsic approaches are generally autonomous, intrinsic systems often require an external trigger for the self-repair process. This can be in a form of thermo-mechanical, electrical, photo-stimuli, etc.

At the moment, in the **Laboratory for polymers and composites, Department of materials**, we deal with a co-polymer of ethylene and methacrylic acid with self-healing ability that can be thermally activated. This thermoplastic material is transparent and it has moderate mechanical properties. We improved the mechanical properties with carbon fibres. We performed ballistic tests on the neat polymer with different weapons and we tested mechanical properties after ballistic tests were performed. The stiffness of the material remains the same, but there is a drop in the strength of the material.

Our tests as well as literature sources [1,2] showed that the introduction of self-healing materials may be a solution for some applications, but still one has to be aware that some properties cannot completely recover. There are many possibilities for variation of this material by introducing different reinforcing materials.

[1]R. White, N. R. Sottos, P. H. Geubelle, J. S. Moore, M. R. Kessler, S. R. Sriram, E. N. Brown S. Viswanathan Autonomous healing of polymer composites, Nature 409, 2001.

[2] J. Asadi, N. G. Ebrahimi, M. Razzaghi-Kashani Self-healing property of epoxy/nanoclay nanocomposite using poly(ethylene-co-methacrylic acid) agent Composites Part A: Applied Science and Manufacturing, Vol. 68, 2015.