Editorial corner – a personal view

Sunlight stimulated repeated self-healing

*M. Q. Zhang**

Materials Science Institute, Sun Yat-sen (Zhongshan) University, Guangzhou 510275, P. R. China

The sun provides limitless power for earth. Solar energy has been harnessed in many aspects. For example, plants live on photosynthesis induced by sunlight. With respect to the products made from polymers, however, sunlight is recognized to be an undesirable factor responsible for aging.

Fortunately, anything which is negative can be turned to positive. In case photoreversible bonds are introduced to macromolecular chains, damages in polymers can be self-healed under sunlight stimulus. Because the use of light is clean, cheap and readily available, such an unconscious way of remending is obviously advantageous.

In a recent proof-of-concept experiment of our laboratory [J. Mater. Chem., DOI: [10.1039/C1JM13467A](https://doi.org/10.1039/C1JM13467A)], a novel coumarin derivative was synthesized and attached to a conventional covalently bonded polymer (i.e. polyurethane) as photosensitive crosslinker. Upon mechanical damage, the crosslinkages (i.e. coumarin dimers) of polyurethane network preferentially cleave returning to original coumarin moieties. Then, these coumarin moieties can be reconnected by illumination of 350 nm UV light (a major component of sunlight). The entire cycle is fully reversible. By using this habit, broken polyurethane are repeatedly re-bonded under sunlight, without the necessity of any catalyst, healing agent or surface treatment.

The research on photochemical self-healing has only just begun and is still in infancy. In principle, reversible photochemical reaction is hard to proceed in solid polymer for structural application because molecular motion is restricted. The key

issues seem to be that (i) the photosensitive segments on the fractured surface should be mobile enough, which favors wetting and diffusion of molecules at the solid-solid contact of the damaged parts to meet the molecular level movement requirement of crack healing; and (ii) macroscopic flow of the material should be prohibited during crack healing, maintaining load-bearing capacity of the material.

Repeated damages are very common in daily life, like scratches on cars made by automatic brush washing and those on touch screens by fingernails. Although exterior paint that obscures scratches was developed by automotive industry, it works due to heating of the sun rather than photochemistry. Only fine scratches appearing in the form of plastic deformation can be recovered. In contrast, the sun stimulated photoreversible reaction is able to re-bond completely damaged polymeric materials, despite the healing efficiency in terms of mechanical strength restoration is not that satisfactory for the moment. Evidently, the strategy is promising for developing a variety of next generation coatings, films and sheets to meet aesthetic, structural and functional requirements.

Prof. Dr. Ming Qiu Zhang
Member of International Advisory Board

*Corresponding author, e-mail: ceszmq@mail.sysu.edu.cn
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