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Rubber composites with self-healing ability

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Self-healing materials have intensively been investigated over the past 15 years. Several approaches have been developed resulting in materials capable of dealing with damage events in a more or less independent way, thereby extending their service life and thus reducing waste. Large interest has been drawn to self-healing elastomeric materials, following either extrinsic or intrinsic approaches. However, limited attention has been paid to the self-healing of vulcanized rubbers. Healing is especially challenging in vulcanized rubbers, where the confinements imposed by the high density of cross-links restrict polymer chains to diffuse and form new bonds across former (pre-) fractured surfaces. We will discuss the development of rubber compounds with self-healing properties. While it is relatively easy to demonstrate the occurrence of self-healing (i.e., the restoration of mechanical properties) the underlying physico-chemical reactions which take place at molecular level during the healing process are less easy to be monitored. Thus, a systematic research on the molecular dynamics of these elastomers will help to elucidate the key healing reactions and how the relaxation behavior of the compounds can be affected by the degree of curing. In addition, the majority of studies covering the healing of polymer composites report on the healing of structural properties and on the use of reinforcing agents (e.g., nanofillers) for improving the mechanical performance. However, nanofillers can also be used for restoring other functionalities, i.e., non-mechanical properties such as thermal conduction, electrical conduction and magnetic shielding among others. Our aim is to restore more than one functionality after healing macroscopic damage in rubber nanocomposites. This study also focuses on the development of rubber composites that can combine together self-healing properties with the use of ground tire rubber (GTR) as alternative sustainable filler. The self-healing efficiency of GTR filled rubber composites will be compared to conventional carbon black filled compounds. These results will be seen as a starting model material for developing new sustainable applications economically and environmentally convenient with good mechanical properties as well as healing ability.

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