Editorial corner – a personal view

Current issues for rubber crosslinking and its future trends of green chemistry strategy

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Crosslinking is an essential chemical process generally applied to rubbery or elastomeric materials. It occurs by forming cross-links between sections of macromolecules, resulting in a three-dimensional molecular network. Cross-linked rubber is endowed with unique entropic elasticity which makes rubber to maintain its shape after large deformation.

In most cases, the traditional and dominant curing methods depend on sulfur curing system by employing the reaction between sulfur and large amounts of double bonds in the polyolefin rubbers. Furthermore, the sulfur curing system has been modified by systematic innovation of curing additives including accelerators, activators, and retarders. However, the sulfur curing process could release toxic volatile organic compounds (VOCs), which has aroused great concerns over the environmental impact around the world. The VOCs are also of unpleasant smell because of the existence of amines and sulfur-containing organic compounds. What's more, some curing additives have inherent toxicity. Since April 2004, the European Union has legislated that the dosage of a common activator (zinc oxide) must be reduced because of its toxicity to aquatic organisms (2004/ 73/EC). Moreover, some accelerants are classified as dangerous substances according to the directive of European Union laws (67/548/EEC). For example, the

accelerant tetramethylthiuram disulfide (TMTD) can generate nitrosamine which is a carcinogen. From the view of crosslinking performance, some curing additives, such as accelerants and sulfur, have poor solubility in rubber and tend to migrate to the surface of rubber products over time, resulting in blooming phenomenon and unsatisfactory crosslinking performance. World rubber industry is eager to see the emergence of new generation crosslinking systems with green nature and satisfactory crosslinking performance. However, many efforts failed due to the huge challenge.

To tackle the above serious issues, a new and green curing strategy is put forward to the crosslinking of polyolefin rubbers. In this new route, (i) new rubber macromolecules with new functional groups rather than double bonds as crosslinking sites need to be synthesized or chemically modified; (ii) green organic molecules with di- or multi-functionality need to be developed as crosslinking agents instead of the sulfur system. Consequently, the effective yet simple curing strategy may open up green avenues to address the environmental issues caused by the traditional curing methods. Note that, the new green strategy must also match the requirement of necessary crosslinking performance and satisfactory mechanical performance. The specific examples will be reported by authors in the future.

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