New Approaches to Increase the Compatibility of Natural Rubber and Silica for Reduction of Rolling Resistance of Truck and Bus Tires

By:

Wilma Dierkes, Karnda Sengloyluan, Wisut Kaewsakul, Jacques Noordermeer, Kannika Sahakaro, Anke Blume

Department of Rubber Technology and Polymer Science, Faculty of Science and Technology, Prince of Songkla University, Pattani Campus, Thailand
Elastomer Technology and Engineering, Dept. of Mechanics of Solids, Surfaces and Systems (MS3), Faculty of Engineering Technology, University of Twente, Enschede, the Netherlands

Since the introduction of the “Green Tire Technology” by Michelin for passenger car tire treads in the early nineties of last century, it has shown a steady increase in market acceptance. It makes use of silica rather than carbon black for tire reinforcement. The technology basically depends on chemical coupling of the silica to elastomers via coupling agents rather than physical interaction in the case of carbon black. The much stronger chemical coupling reduces hysteresis at higher temperatures, so reducing the rolling resistance of tire treads based on that technology, while keeping the wet skid and wear-resistance at least as good, and preferably improving these also. With the major steps taken in the beginning, gradual further improvements were/are made by improved coupling agents and lately also by chemically modified elastomer types which enhance the chemical interaction.

The application of this technology to Natural Rubber (NR), particularly for truck tire treads, has remained a bit hampered, because the NR molecular structure does not easily allow for sufficient reactivity towards coupling agents without major molecular breakdown. The presentation will cover three approaches taken in an attempt to overcome these shortcomings:

- Epoxidation of NR (E-NR), where the E-NR is used as the base polymer, in order to reduce the dependence on the coupling agent;
- E-NR at higher degrees of epoxidation used as compatibilizer between straight NR and silica, similarly to reduce the dependence on the coupling agent;
- NR grafted with coupling agents prior to mixing with silica.

All three approaches lead to improved performance relative to straight NR combined with silica and a coupling agent.