Utilization of organoclay as secondary filler in silica-reinforced natural rubber for tire tread compounds

Suppachai Sattayanurak[1,2], Kannika Sahakaro[1, a], Wisut Kaewsakul[2], Louis A.E.M. Reuvekamp[3], Wilma K. Dierkes[2], Anke Blume[2], and Jacques W.M. Noordermeer[2]

[1]*Department of Rubber Technology and Polymer Science, Faculty of Science and Technology, Prince of Songkla University, Pattani Campus, 94000 Thailand*
[2]*Elastomer Technology and Engineering, Department of Mechanics of Solids, Surfaces and Systems, Faculty of Engineering Technology, University of Twente, P.O.Box 217, 7500AE Enschede, The Netherlands*
[3]*Apollo Tyres Global R&D B.V., Colosseum 2, 7521PT Enschede, The Netherlands*

[a)]Corresponding author: *kannika.sah@psu.ac.th*

Keywords: natural rubber, tire tread, silica, nanoclay, reinforcement

Driven by a need to enhance fuel-efficient tires, tread compounds have been investigated extensively making use of silica-silane technology as a basis. Several approaches have been adopted to enhance the performance of tire treads, especially with respect to rolling resistance, wet grip, and wear resistance. One of the methods is by use of secondary filler especially nanoclay. The mixing of silica-reinforced natural rubber (NR) tire tread compounds with organoclay (OC) as secondary filler required the optimum mixing dump temperature as that of the silica-only system. The increased dump temperature leads to a lower mixing torque, Mooney viscosity, and Payne effect due to a better silanization reaction. Based on the study using a silica/OC ratio of 45/10 phr, the optimum mixing dump temperature was at 150°C. By substituting the silica by OC from 0 to 36 wt% relative to total filler content in the silica-filled NR compounds, the increased OC loadings decreased the Payne effect and compound viscosities, shortened scorch and cure times, and raised the loss tangent at -20 and 0°C. The optimum loading of OC of 9 wt% relative to total filler content shows better Payne effect, cure rate index, tan delta at -20 indicative for ice traction, and 60°C indicative for rolling resistance, and abrasion resistance, compared with the pure silica-filled system. As commercial OC contains a large proportion of surface modifier, the effect of such modifier of dimethyl dihydrogenated tallow ammonium chloride (2HT) type was also elucidated. The NR compounds with silica/OC, silica/montmorillonite (MMT)/2HT added *in situ* during mixing, and a silica-only system were comparatively studied. The 2HT modifier provides positive effects on the performance of silica-NR compounds irrespective in which form it was added. The presence of 2HT suppresses filler flocculation and improves processability. Even though, overall the silica-only filled compound shows better mechanical properties than the silica/clay dual filler systems, but with the optimum content of 2HT, a higher loss tangent at –20 °C and lower loss tangent at 60 °C is obtained, indicating its potential to be used in the silica-based tire tread compounds to improve wet traction and rolling resistance.

References

1. S. Sattayanurak, K. Sahakaro., W. Kaewsakul, W.K. Dierkes, L.A.E.M. Ruevekamp, A. Blume and J.W.M. Noordermeer, Rubber Chem. Technol. **94**, 121-144 (2021).
2. S. Sattayanurak, K. Sahakaro., W. Kaewsakul, W.K. Dierkes, L.A.E.M. Ruevekamp, A. Blume and J.W.M. Noordermeer, Express Polym. Lett. **15**, 666-684 (2021).