

ABSTRACT BOOK



THE 3<sup>rd</sup>  
ASIA PACIFIC  
**APRC** 2017  
RUBBER CONFERENCE



**16<sup>th</sup>-17<sup>th</sup> November 2017**

Prince of Songkla University,  
Surat Thani Campus

**Surat Thani, Thailand**



UNIVERSITI SAINS MALAYSIA



---

## Rubber Chemistry and Chemical Modification

### Reinforcement Efficiency of Silica-Reinforced Natural Rubber Compounds with Different Incorporating Steps of Diphenyl Guanidine

C. Hayichelaeh<sup>1,2</sup>, L.A.E.M. Reuvekamp<sup>2,3</sup>, W.K. Dierkes<sup>2</sup>, A. Blume<sup>2</sup>,  
J.W.M. Noordermeer<sup>2</sup>, K. Sahakaro<sup>1</sup>

<sup>1</sup>Department of Rubber Technology and Polymer Science, Faculty of Science and Technology, Prince of Songkla University, Pattani Campus, 94000 Thailand

<sup>2</sup>Elastomer Technology and Engineering, Department of Mechanics of Solids, Surfaces and Systems (MS<sup>3</sup>), Faculty of Engineering Technology, University of Twente, P.O. Box 217, 7500AE Enschede, The Netherlands

<sup>3</sup>Apollo Tyres Global R&D B.V., Colosseum 2, 7521PT Enschede, The Netherlands

---

**Abstract:** Diphenyl guanidine (DPG) is commonly used as a secondary accelerator in the silica-filled rubber compounds in order to synergize the sulfenamide primary accelerated sulfur vulcanization and to promote the silanization reaction between the silanol group on the silica surface and alkoxy groups of the silane coupling agent. The latter reaction takes place during mixing, therefore, the influence of different incorporating steps of DPG on the properties of silica-reinforced NR compounds are investigated. DPG was added in an internal mixer, on a two-roll mill or separate addition (half in an internal mixer and another half on a two-roll mill). Due to promoting the silanization reaction by DPG, the rubber compounds with DPG present in the internal mixer show higher chemically bound rubber content than the mixing method with all DPG added on a two-roll mill. The different mixing methods give similar Payne effect which indicates similar levels of filler-filler interaction and filler dispersion within the rubber compounds. But, the mixing methods exhibit an effect on dispersion stability as indicated by their different flocculation rate constants. The use of the mixing method where the DPG was separately added shows the best balance between the interfacial compatibility between the silica surface and the rubber matrix on the one hand, the cross-linking network within the rubber as evaluated from the Mooney-Rivlin plots on the other hand, and additionally the tensile properties, i.e. modulus and tensile strength.

---