

# **Sustainable green material: replacing aromatic oil by renewable palm oil in natural rubber/silica composites**

Hassarutai Yangthong<sup>a</sup>, Papawarin Udomsin<sup>a</sup>, Supitta Suethao<sup>a,b</sup>, and Wirasak Smitthipong<sup>a,b</sup>

<sup>a</sup> *Specialized Center of Rubber and Polymer Materials in Agriculture and Industry (RPM), Department of Materials Science, Faculty of Science, Kasetsart University, Bangkok 10900, Thailand*

<sup>b</sup> *Hub of talents in natural rubber under National Research Council of Thailand, National Research Council of Thailand (NRCT), Bangkok, 10900, Thailand*

Rubber composites based on vegetable oils are being increasingly developed as these materials significantly reduce the use of petroleum-based carcinogenic oils as plasticizers in rubber products. In this work, palm oil (PO) was used as green processing oil for natural rubber (NR) composites and aromatic oil (AO) was also chosen to be investigated for comparison. The preparation of the composites by the latex method with and without vulcanizing agent were also compared with the conventional preparation method. The test results showed that the replacement of AO by PO in Latex method showed similar cure rate index. Moreover, the energy-efficient latex method indicated a delta torque close to that of the conventional method. The findings indicated that a presence of PO in the NR/silica composites produced equivalent filler-filler. The Payne effect, concerning filler-filler interactions of the rubber compounds with AO and PO, was measured about 180 and 170 kPa, respectively. The mechanical properties of PO application were close to those of AO application; however, the life cycle assessment (LCA) analysis indicated that the use of PO was better. Therefore, the substitution of AO with PO in rubber compound offers improved environmental sustainability due to its renewable and cleaner origin. Additionally, palm oil enhances the dispersion of fillers and maintains comparable mechanical properties, making it a viable eco-friendly alternative plasticizer.

**Keywords :** Natural rubber, Palm oil, Aromatic oil, Silica, Life cycle assessment