

Utilization of π - π stacking interactions for improving carbon black dispersion in epoxidized natural rubber

Kwanchai Buaksuntear¹, Phillip Kohl², Youli Li², Wirasak Smitthipong^{1,3}

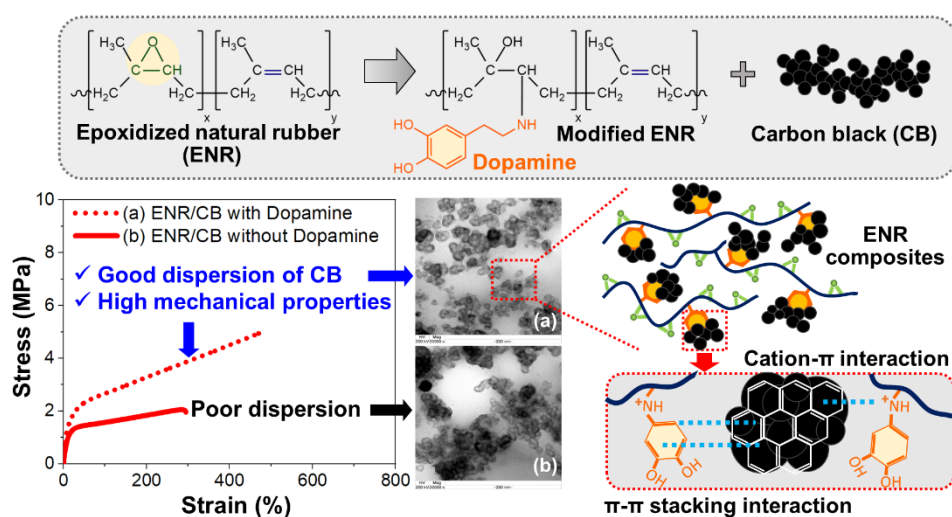
e-mail: fsciwssm@ku.ac.th

¹Specialized Center of Rubber and Polymer Materials in Agriculture and Industry (RPM),
Department of Materials Science, Faculty of Science, Kasetsart University, Bangkok 10900, Thailand.

²Materials Research Laboratory and BioPACIFIC MIP, University of California, Santa Barbara,
California, 93106, United States.

³Hub of Talents in Natural Rubber, National Research Council of Thailand (NRCT), Bangkok 10900, Thailand.

Natural rubber (NR) is derived from *Hevea brasiliensis* plants. NR exhibits good elasticity and mechanical properties. However, the oxidation is occurred due to the double bonds in molecules [1]. The epoxidation reaction is applied to modify NR, resulting in epoxidized natural rubber (ENR) [1]. In terms of rubber processing, carbon black (CB) aggregation is one of the important problems for rubber manufacturing [2]. The present research aims to solve the CB aggregation using the bio-inspired from mussel mechanism with aromatic interactions in ENR composites. Initially, the NR was chemically modified to obtain ENR. Then, the 20 phr of dopamine (D) was grafted onto the ENR chains. The CB content was various at 30, 40, and 50 phr, respectively. In this study, a variety of aromatic interactions (i.e. π - π stacking and cation- π interactions) were obtained between the benzene ring in D-grafted ENR chains and the surfaces of CB, which detected by FTIR and Raman spectroscopy [3]. Interestingly, the slope of SAXS/WAXS indicated that the CB particles were well dispersed in ENR matrix by the π - π stacking and cation- π interactions. These results were in good agreement with the TEM and RPA results [3]. Furthermore, the ENR/CB with dopamine exhibited the highest of the tensile properties and good energy-saving property due to the effect of CB reinforcement and the aromatic interactions. Finally, this research provides a novel approach based on a bio-inspired mechanism to solve the CB aggregation problem in rubber products, resulting in the ENR composites with superior performance properties.



References 1) K. Buaksuntear, et al., *Polymer* 291, 126626 (2024). 2) R. Fauche, et al. *ACS Appl. Nano Mater* 7, 3610 (2024). 3) K. Buaksuntear, et al., *ACS Appl. Polym. Mater.*, 7, 3576 (2025).