

# Novel natural rubber-*g*-*N*-(4-hydroxyphenyl)maleimide: synthesis and its preliminary blending products with polypropylene

Charoen Nakason · Krisna Sasdipan ·  
Azizon Kaesaman

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**Abstract** Graft copolymer of natural rubber and *N*-(4-hydroxyphenyl)maleimide (i.e., NR-*g*-HPM) was synthesized. It was found that the grafting yield increased upon increasing the grafting temperature and the highest grafted HPM content was obtained at 200 °C. Furthermore, increases in concentration of HPM led to drop in grafted HPM. Therefore, an optimum grafting temperature and dose of HPM were found to be 200 °C and 2 phr, respectively. Dynamically cured 60/40 NR-*g*-HPM/PP blends with various loading levels of HPM in graft copolymerization were then achieved by dynamic vulcanization. It was found that the blend with 2 phr of HPM exhibited the highest tensile strength, elongation-at-break, mixing torque during dynamic vulcanization, storage modulus and complex viscosity and the lowest tension set (i.e., the highest elasticity). This was attributed to the highest grafted HPM which created greater possibility to form linkage between NR-*g*-HPM and the phenolic modified PP compatibilizer molecules which promoted easier interactions between the blend components. TGA analysis found that the NR-*g*-HPM/PP blends exhibited two stages of weight loss while the pure PP exhibited a single stage. Furthermore, the NR-*g*-HPM/PP blend exhibited higher degradation temperature than that of the unmodified NR/PP blend which was the confirmation of higher heat resistance of NR-*g*-HPM.

**Keywords** Natural rubber ·  
*N*-(4-hydroxyphenyl)maleimide · Graft copolymer ·  
Thermoplastic vulcanizate · Polypropylene

## Introduction

Natural rubber molecules show low resistance to oxidation, UV irradiation, weathering, chemical and thermal stability. Therefore, chemical modification of NR molecules has been widely practiced to enhance those useful properties and to extend NR scope of applications. There are various NR products that have been chemically modified including maleated natural rubber (MNR) [1, 2], epoxidized natural rubber (ENR), hydrogenated natural rubber (HNR), chlorinated natural rubber (CNR) [3, 4], natural rubber grafted with various types of polymers, such as natural rubber-*g*-poly(methyl methacrylate) (NR-*g*-PMMA), natural rubber-*g*-polystyrene (NR-*g*-PS) [5, 6] and natural rubber-*g*-poly(dimethyl(methacryloyl oxymethyl)phosphonate) (NR-*g*-PDMMMP) [7].

Graft copolymers of natural rubber have the potential application to be used as compatibilizers for blending NR with other polymer components, which are identical to the grafted chains with similar polarity. These include blending of NR with poly(methyl methacrylate) with the aid of NR-*g*-PMMA [8] and similarly with polystyrene by using NR-*g*-PS [9] and blending with EVA by using NR-*g*-PDMMMP as compatibilizers [7]. In addition, natural rubber-*g*-maleic anhydride [1, 10] and NR-*g*-PMMA [5, 11] have been used as the main blend components to enhance some useful properties such as solvent resistance and anti-degradation.

*N*-(4-hydroxyphenyl)maleimide (HPM) is an interesting monomer, since it consists of pendant phenol group which could be introduced into the polymer backbone by

C. Nakason (✉) · K. Sasdipan · A. Kaesaman  
Department of Rubber Technology and Polymer Science,  
Faculty of Science and Technology, Center of Excellence in  
Natural Rubber Technology (CoE-NR), Prince of Songkla  
University, Pattani 94000, Thailand  
e-mail: charoen.nakason@gmail.com