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Application of cellulose nanocrystals as a green filler for the development of sustainable rubber latex-based coatings

D. V. N. K. Dayarathne, K. M. N. de Silva, and W. R. M. de Silva*

Department of Chemistry, University of Colombo, Colombo 03, Sri Lanka

Although coatings are a rapidly developing entity in the paint industry, most paint coatings encounter cracks over time. This study mainly focused on developing a sustainable paint coating to remediate the problem of cracking. In this regard, natural rubber (NR) latex–cellulose nanocrystal (CNC) based nanocomposites were prepared and the optimized nanocomposite was incorporated into the paint formula as the polymer component. CNCs were used as the nanophase of the nanocomposite and extracted from microcrystalline cellulose (MCC) using alkali pre-treatment followed by acid hydrolysis. Morphological analysis, chemical properties, crystallinity and crystallite size of CNC were investigated. The average particle sizes of MCC and CNC were approximately 30 µm and 10 nm, respectively while CNC appears to be brittle and wrinkled. All FT-IR absorption bands and XRD diffraction peaks obtained for CNC and MCC were characteristic of cellulose I. NR was used as the polymer phase of nanocomposite due to its extraordinary elasticity. In this study, the CNC loading varied from 0 to 7.5 phr and mechanical properties of NR/CNC nanocomposite were investigated using tensile testing. The highest average tensile strength (TS) was achieved when 5.0 phr of CNC was used. Furthermore, TS of nanocomposite increased when CNC content was increased up to 5.0 phr and TS decreased when CNC content is higher than 5.0 phr. In addition, a decrease in elongation at break values with increasing CNC loading was observed. The paint coating was developed by replacing the conventional acrylic polymer with the optimized NR/CNC nanocomposite. However, after applied and thoroughly dried, optimized nanocomposite incorporated paint mixture was started to peel off from the surface, indicating poor adhesion property. Therefore, a polymer blend with nanocomposite and acrylic polymer was used in the paint mixture at a blending ratio of 3:1 and it exhibited a logical average TS. Furthermore, it was well-dispersed and dried completely within 5-6 hours upon application on the surface. The novel paint mixture was stable and no visual defects were detected after 6 months. This study shows that the 3:1 polymer blending ratio incorporated paint has the potential to be used as a sustainable paint coating.

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E-mail: rohini@chem.cmb.ac.lk