Conductive Natural Rubber Composites with Soft-robotic Motion Sensor for Disinfectant Prosthesis Device

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Abstract

One of the limitations of using natural rubber (NR) as the flexible composites for detecting object movement is the uncreatable of specific signals. Fabrication of the conductive NR composites was therefore produced by using a combination of carbon nanotubes (CNT) and conductive carbon black (CCB) hybrid filler. The formation of CNT/CCB conductive network inside the NR matrix provides electron transferring throughout the composites. Following the conductivity of the flexible conductive NR composites (FCNC), piezoresistive properties allow new possibilities for applying FCNC to the motion sensor application [1]. However, in real use, the challenge is not only the suitable concentration of the hybrid filler with the selected processing procedure, but also the received properties, particularly the optimal electrical conductivity. The higher conductivity refers to higher sensitivity of the sensor in both high and low strain periods. Although the ionic liquid (IL) has been used for increasing conductivity, lowering mechanical and dynamical properties of the composites are often reported. This causes the finding of new IL, so-called deep eutectic solvent (DES), which can mix to the FCNC and the enhanced conductivity with improved other specific properties are shown. The DES-based FCNC had also increased piezoresistive of the composites, showing the smooth signal without noise and un-prediction electrical peaks [2]. According to the upcoming circular economy, recyclability of the FCNC is considered and can be applied through the preparation as the thermoplastic vulcanizates (TPV) [3]. The non-conductive and conductive TPV were prepared for the producing possibility of prosthesis application which has required soft-touch thermoplastic material with cost-effectiveness. Shape fabrication was carried out from 3D printing technologies under proper engineering-based simulation mechanisms. TPV filament was extruded through the multi-material extrusion additive manufacturing (MEX-AM) using the thermoplastic polyurethane (TPU) as the chosen thermoplastic matrix. Thus, the piezoresistive properties of the TPV-based prosthesis finger with installation of DES-based FCNC were proposed. Also, the new design as the prosthesis foot together with disinfectant performance to the negative-gram and positive-gram bacteria was shown based on the disinfectant efficiency of NR film and EVA foam. The present work therefore represented the new possibility for using the NR in an advanced material which fitted well with the global market under the multidisciplinary skill of research.

Keywords: Natural rubber, Hybrid filler, Electrical conductivity, Piezoresistive properties, Prosthesis devices