A Nature-Inspired Superhydrophilic Nano-Powder based Silicone Rubber Composite

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Abstract

Silicone-Rubber (SR) is an elastomer prominently used in biomedical and medical devices, implants, and winter shoe industries because of its stability, durability, frictional properties, biocompatibility, anti-bacterial, temperature resistance, and hypoallergenic characteristics. However, inherent hydrophobicity limits the use of SR as it cannot form a protective liquid layer for implants and medical devices while placed internally or externally and impairs tissue adhesion as well. Apart from that, modern sensing E-skin patches struggle to provide accurate measuring results of the quantity to be measured due to skin perspiration. The electrodes of the sensors on the skin cannot read properly and adhesion of these sensing E-patches is also severely impaired. On the other hand, hydrophobicity reduces ice adhesion strength in the absence of capillary bridges and that makes winter shoe-soles more slippery. The physical and chemical solutions like oxidation, UV, plasma, corona discharge, gamma radiation, and Laser radiation grafting to turn SR into hydrophilic are either temporary or change the bulk properties of the compounds. We propose an innovative multifunctional SR composite incorporating zirconia and/or titania nanoparticles produced by roller mixing followed by hot compression moulding (pressure-heating vulcanisation). Subsequently, nature-inspired patterns like gecko or frog toepads are produced on SR compound by Laser-Surface-Texturing (LST) to expose the nanoparticles that attract water molecules. A parametric optimisation along with nano powder percentage decides the wettability of the composite. A permanent superhydrophilic SR compound was produced that can be useful in increasing adhesion on wet surfaces whether slippery ice surfaces or human skin, or the surfaces for other biomedical applications.

Introduction