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# Development of robust superhydrophobic plastic sheets using diatomaceous earth

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Superhydrophobicity is the ability of a surface to repel water droplets. Surfaces that exhibit a static water contact angle (WCA) exceeding 150° and a sliding angle less than 10° can be defined as superhydrophobic surfaces. The unique properties of superhydrophobicity include self-cleaning, drag reduction, anti-fouling, anti-corrosion etc. Several methods are employed in developing superhydrophobic surfaces, yet incorporating a superhydrophobic filler is a more convenient method which is utilized in this research. This study discusses a progressive development of a method to enhance the hydrophobicity of plastic substrates using Diatomaceous Earth (DE) as the superhydrophobic filler. In this study, the focus was on developing superhydrophobic plastic substrates with enhanced mechanical durability and stability since one of the primary concerns of superhydrophobic surfaces is their mechanical performance. The fundamental requirements for producing superhydrophobic substrates are nanoscale surface roughness and low surface energy. The nanoscale surface roughness was obtained through DE, whereas low surface energy was attained by treating DE with hexadecyltrimethoxysilane (HDTMS). The surface wettability and morphology were evaluated through WCA measurements and scanning electron microscopy (SEM) analysis, respectively. By using HDTMS to DE ratio of approximately 38% (w/w), superhydrophobic properties were achieved for treated DE with WCA around 160°. In the first approach, treated DE was incorporated into plastic substrates through melt mixing process to achieve the inbuilt hydrophobic property. Incorporation of treated DE into high-density polyethylene through melt mixing process resulted in hydrophobic plastic sheets possessing WCAs of around 99° with treated DE particle loading of 10%. The treated DE amount was not further increased due to the reduction of mechanical properties of the plastic sheet. The hydrophobicity did not reach the expected level. As revealed by SEM and SEM coupled with energy dispersive X-ray analysis, the DE particles had been destroyed and trapped within the plastic matrix during the melt mixing process. Compression molding technique was also employed to fabricate a thin layer of treated DE on the plastic substrates. Yet, it was observed that the adhesion between the DE layer and the plastic substrate was not satisfactory and the WCAs were drastically reduced after removing the loosely bound DE powder of the coating. By utilizing the solvent casting method and a subsequent lamination step, robust superhydrophobic coatings on poly(vinyl chloride), which can be considered as a polar plastic substrate, were successfully developed. The coating consisted of treated DE particles held together by an epoxy resin binder, ensuring both the cohesion of the coating and its robust adhesion to the substrate. The prepared coatings showed a remarkable level of superhydrophobicity, surpassing the threshold WCA of 150° and good mechanical properties.

**Keywords:** Coatings, Contact angle, Diatomaceous earth, Robust, Superhydrophobic

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