Junior Science Communications
Faculty of Applied Sciences, UiTM Shah Alam
https://journal.uitm.edu.my/ojs/index.php/JSC

E-ISSN 2637-0689
Vol 53 2025

Colloquium on Applied Sciences 1 2025
20-28 January 2025, Faculty of Applied Sciences, UiTM Shah Alam, Malaysia

Mechanical Properties of 3d-Printed Thin Film Functionalized with Various Concentrations of Graphene Oxide Nanocomposites for Potential Membrane Applications

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Structured Abstract

Background: Although membranes' mechanical properties have a significant impact on how well it works, obtaining the perfect ratio of strength, flexibility, and durability in membrane technology is still difficult. Traditional membranes frequently have poor mechanical properties, which reduces their use in environmental and industrial processes like filtering, separation, and purification. This study investigates the use of additive manufacturing techniques or three-dimensional (3D) printing technique to fabricate membranes functionalized with graphene oxide (GO) nanocomposites in order to overcome these constraints. GO has a great deal of potential to improve membrane performance because of its strong mechanical strength, broad surface area, and chemical flexibility. However, more research is needed to determine how GO content, dispersion, and structure influence the mechanical properties of 3D membranes.

Methods: In this study, polyurethane acrylate (PUA)-based 3D membranes with different GO concentrations (e.g., 0.01 wt%, 0.05 wt%, 0.1 wt%, and more) were created using Digital Light Processing (DLP), a sophisticated 3D printing technique. To guarantee printability and even dispersion of GO fillers, the viscosity of the PUA/GO matrix was initially determined using a viscometer. A Universal Testing Machine was used to evaluate the membranes' mechanical characteristics, such as their tensile and flexural strength. The microstructural distribution of GO and its interaction with the polymer matrix were studied using Energy Dispersive X-ray (EDX) analysis and Field Emission Scanning Electron Microscopy (FESEM).

Results: The results showed that adding GO greatly increased the membranes' tensile strength, modulus, and flexibility; the ideal mechanical performance was achieved with 0.05wt% GO. Higher GO concentrations (0.1wt%), however, caused agglomeration, which decreased dispersion homogeneity and prevented further improvements. The advantage of using 3D-printed technique is can customize the weight percentage of GO which corporate well with PUA as a matrix to form a high mechanical properties of 3D-printed membranes. The dispersion quality of GO nanocomposites was found to be crucial in affecting membrane performance, according to FESEM images.

Conclusion: In conclusion, adding GO nanocomposites to 3D-printed membranes improves their mechanical characteristics; the best outcomes are obtained at optimal concentrations. By advancing membrane technology, this study gives possibilities for the use of high-performance membranes in environmental and industrial applications.

Keywords: Graphene oxide, 3D printing, membranes, mechanical properties, nanocomposites,

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