Beni-Suef university
Faculty of Technology and Education
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كلية التكنولوجيا والتعليم
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# « Study the Effect of Adding Some Nanomaterials on the Mechanical and Tribological Properties of Polymer Composite Materials »

A Thesis Submitted to the Faculty of Technology and Education, Beni-Suef University in Partial Fulfillment of Requirements for the

**Master's Degree**

in Industrial Education, Mechanical Department (Production)

**Presented by:**

**Eman Mohamed Mohamed Ali**

**Demonstrator, Production Technology Department, Faculty of Technology and Education, Beni-Suef University**

**Beni-Suef, 2022**

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***Eman Mohamed Mohamed Ali***

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## List of Abbreviations

| Abbreviation | Meaning |
|---|---|
| PNCs | Polymeric Nanocomposites |
| PMMA | Poly (Methyl Methacrylate) |
| MMA | Methyl Methacrylate |
| NPs | Nanoparticles |
| $TiO_2$ | Titanium Dioxide |
| DS | Date Seed |
| $TiO_2$ NPs | Titanium Dioxide Nanoparticles |
| DS NPs | Date Seed Nanoparticles |
| VHN | Vickers Microhardness Number |
| COF | Coefficient of Friction |
| SEM | Scanning Electron Microscope |
| PE | Polyethylene |
| PS | Polystyrene |
| PP | Polypropylene |
| LDPE | Low-Density Polyethylene |
| HDPE | High-Density-Polyethylene |
| PET | Polyethylene Terephthalate |
| PVC | Polyvinyl Chloride |
| ABS | Acrylonitrile Butadiene Styrene |
| PA | Polyamides |
| PC | Polycarbonate |
| PNCs | Polymer Nanocomposites |
| Vol. % | Volume Fraction Percentage |
| wt. % | Weight Fraction Percentage |

| | |
|---|---|
| Micro | Micro One Millionth of A Meter |
| Nano | One Billionth of A Meter |
| Pico | One Trillionth of A Meter |
| FTIR | Fourier Transform Infrared Spectrscopy |
| TEM | Transmission Electron Microscopy |

## Abstract

The main aim of this study is to study the effect of $TiO_2$ nanoparticles ($TiO_2$ NPs) and Date Seed Nanoparticles (DS NPs) on the mechanical and tribological characteristics of (PMMA).To technique fabricate the composites was used cold-cured. And specimens were fabricated directly without heat treatment. Two groups of specimens were fabricated, the first group by addition of $TiO_2$ NPs to PMMA with different weight fractions (wt.%) of 0-1.2 and 1.5 wt.%. For the second group, DS NPs were added to PMMA with the same wt.%. Effect of $TiO_2$ NPs and DS NPs content on Vickers microhardness number (VHN), the elastic modulus, wear rate, and coefficient of friction (COF) of all nanocomposites have been investigated. The pin-on-disc tester achieved the tribological characteristics under loads 10, 20, and 30 N applied at constant sliding speed and sliding distance of 1.256 m/s and 226 m, respectively. Then, the worn surfaces were characterized by (SEM) scanning electron microscope after the wear test.

For cold (self) nanocomposites, experimental results uncovered that microhardness, the elastic modulus, COF, and wear rate were improved with increasing nanofiller content up to 1.2 wt. % of $TiO_2$ NPs and DS NPs. Also, the wear rate increased with increasing applied loads up to 30 N, while COF decreased with increasing applied loads up to 30 N. SEM examination showed that the worn surface of pure PMMA contains many ploughed marks and deep grooves. After adding 1.2 wt. % $TiO_2$ NPs and DS NPs into PMMA, mechanical strength of the specimen's surface was improved and dramatically decreased wear grooves. Also, after adding $TiO_2$ NPs and DS NPs to PMMA, more than 1.5 wt.% up to 1.2 wt. %, there were more

ploughed marks and porosity on worn surfaces than PMMA at 1.2 wt.% $TiO_2$ NPs and DS NPs.

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