MECHANICAL PROPERTIES AND PHOTOCATALYTIC PERFORMANCE OF NANOFIBER MEMBRANE FOR ORGANIC DYES UNDER VISIBLE LIGHT (PAN-CNTs/ZnO-NH_2)

By

Eng. Shrouk Abd El-Karim Abo El-Hassan Maghrapy

A Thesis Submitted to the
Faculty of Engineering at Cairo University
in Partial Fulfillment of the
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IN
MECHANICAL DESIGN AND PRODUCTION ENGINEERING

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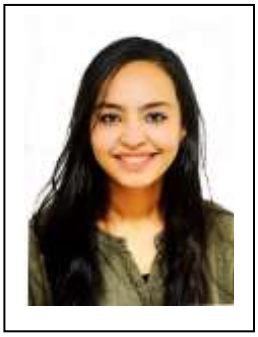

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Title of Thesis:

Mechanical Properties And Photocatalytic Performance Of Nanofiber Membrane For Organic Dyes Under Visible Light PAN-CNTs/ZnO-NH_2

Key Words:
Carbon Nano-tubes, Composite Nano-fibers, Photocatalytic Degradation, Polyacrylonitrile, Nanofibers.

Summary:

The aim of this work is to produce composite nanofibers with adding PAN to the CNTs and crosslinked it by ZnO to study the photocatalytic performance of it. The results shows an enhancement in the characterization and on the mechanical properties that's help to be used in the filtration field. The photocatalytic degradation of organic dyes improved and become faster with using the PAN-CNTs/ZnO-NH_2 under visible light.

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NOMENCLATURE

A	The cross section area of the composite Nanofibers
C	Concentration of the dye solution after irradiation
C_o	Initial Concentration of the dye solution before irradiation
F	The applied force on the Composite Nanofibers
L_O	The gauge length of the composite Nanofibers
pK_a	Log_{10} of the solution acid dissociation constant (K_a)
R	Curvature radius of the electrode
ΔL	The difference between CNF final length and the original length
ε	Strain of the composite Nanofibers
σ	Stress of the composite Nanofibers

ABBREVIATIONS

Al_2o_3	Aluminum oxide
AOP	Advanced oxidation process
CdS	Cadmium Sulfide
CNFs	Composite Nanofibers
Cs	poly cation chitosan
DMF	Dimethylformamide
GA	Glutaraldehyde
HCl	Hydrochloric acid
IC	Indigo Carmine
MB	Methylene Blue
MCNTs	Multi Wallet Carbon Nanotubes
NaOH	Sodium hydroxide
NFs	Nanofibers
NPs	Nano Particles
PAN	Polyacrylonitrile
PET	Polyethylene terephthalate
Ph.D	Photocatalytic Degradation
PMMA	Poly (methyl methacrylate)
POPs	Persistent organic pollutants
PVDF	Polyvinylidene fluoride
PVP	Polyvinylpyrrolidone
SCNTs	Single carbon Nano tubes

Sio_2	Silicon dioxide
TS	Tensile Strength
UV	Ultra Violet
VL	Visible Light
Y'sM	Young's Modulus
ZnO	Zinc oxide
ZnS	Zinc Sulfide
Zro_2	Zirconium oxide
ZTO	Zinc Tin Oxide

Abstract

The water pollution increases every day due to the increase of the humans' behavior so a lot of studies were carried out for looking the solutions. Photodegradation process is a great potential technology due to its merit in degrading the organic pollutants. This process helps on the water treatment process because of its ability in removing different kinds of organic pollutants like herbicides and pesticides by oxidizing it due to the adsorbing light energy during the reaction force in the process. Zinc oxide (ZnO) was used as a photocatalyst in this process due to its large band gap energy.

This work describes the fabrication of the composite nanofibers containing polyacrylonitrile polymer (PAN) and a different weight percentage of carbon nanotubes (CNTs) (0.05, 0.1, 0.5 and 1 wt%) followed by a chemical crosslinking of ZnO nanoparticles (NPs) using electrospinning technique. It is the simplest and highly versatile method to enhance the mechanical properties by removing the surface defects of the composite nanofibers. The tensile test was used to determine the mechanical properties of the composite nanofibers. The result demonstrated that adding CNTs to the polymer enhances the mechanical properties like tensile strengths and Young's modulus with an average 55 and 60 %, respectively at only 0.1wt% of CNTs. In addition, the diameter of the average fibers was 420 nm, and shows good dispersions of CNT into the nanofibers. FTIR, TEM, SEM and XRD analysis are used to examine the changes of the surface morphology, structure and the modification of the fabricated PAN/CNT and PAN-CNTs/ZnO-NH_2 composite nanofibers.

In addition, the photocatalytic degradation performance of the composite nanofiber (PAN-CNTs/ZnO-NH_2) under visible light for the two organic dyes methylene blue (MB) and the indigo carmine (IC) in an aqueous solution were studied. This study has proved that PAN-CNTs/ZnO-NH_2 get high photodegradation efficiency at a low power intensity (80 lux) and at a short time. There are many factors taking into account during the photodegradation process like the pH of the solution, dyes concentration and the irradiation time. The photocatalytic performance studied at different concentration of dyes (10, 30 and 50 ppm) and different dye solution's pH. A complete degradation has done for the dyes solution at very short time 29 min and 115 min for IC and MB respectively at 10 ppm. The maximum photocatalytic degradation performance was found to be a maximum at pH 2, 20 mg of ZnO NPs photocatalyst.