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ORIGINAL PAPER

# Preparation of photo-catalytic copolymer grafted asymmetric membranes (N-$TiO_2$-PMAA-g-PVDF/PAN) and their application on the degradation of bentazon in water

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**Abstract** Nitrogen-doped titanium dioxide (N–$TiO_2$) was prepared and supported on a novel copolymer grafted membrane matrix to avoid the problems associated with the removal of spent photocatalyst from treated water. Membranes of poly (methacrylic acid) grafted onto poly (vinylidene difluoride) and blended with poly (acrylonitrile) (PMAA-*g*-PVDF/PAN) were prepared through a dry–wet phase inversion technique. Methacrylic acid side chains were grafted onto an activated PVDF backbone by the method of reversible addition fragmentation chain transfer polymerization and then the novel photocatalytic asymmetric membranes of N–$TiO_2$–PMAA-*g*-PVDF/PAN were prepared. The casting solutions were blended with 1–5 % N–$TiO_2$ before immersion into the coagulation bath. PVDF and PAN offer several advantages which include: mechanical strength and toughness, chemical resistance, unaffected by long-term exposure to UV radiation, low weight, and thermal stability. N–$TiO_2$ was prepared through sol-gel synthesis. The photocatalytic membranes were evaluated by degradation process of herbicide bentazon in water. Photodegradation studies revealed that the optimum photocatalyst loading was 3 % N–$TiO_2$ and the optimum pH was 7 for the degradation of bentazon in water. UV–Vis, TOC and LC–MS analyses confirmed the successful photodegradation of bentazon. A bentazon removal efficiency of 90.1 % was achieved at pH 7. N–$TiO_2$–PMAA-*g*-PVDF/PAN membranes were successfully prepared and characterized. These photocatalytic membranes showed great potential as a technology for the effective removal of pesticides from water. According to literature, N–$TiO_2$–PMAA-*g*-PVDF/PAN asymmetric photocatalytic membranes have not been prepared before for the purpose of treating agricultural wastewater.

**Keywords** Photocatalysis · Titanium dioxide · Polymer membranes · Photodegradation · Herbicides · Bentazon

## Introduction

Every day a large amount of pollution discharges into rivers and lakes, making them toxic to humans and other forms of life which are dependent on water for their existence [1]. Water pollution can be defined as the contamination of water bodies (surface water e.g., lakes, rivers, oceans, aquifers; and groundwater), mostly by human activities. It transpires when pollutants such as particles, chemicals or substances that contaminate water are discharged directly or indirectly into bodies of water without sufficient treatment to eliminate harmful compounds [2]. The bulk of natural organic matter (NOM) found in water does not pose a direct threat to man.

However, methods like chlorination which is used in the disinfection of drinking water to curb water-borne illnesses result in the formation of various chlorination by-products (CBPs) when chlorine reacts with dissolved organic compounds. Some examples of these chlorination by-products include trihalomethanes (THMs), haloacetic acids (HAAs), etc and these are great threats to natural ecosystems and

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