Preparation, morphological, and mechanical characterization of titanium dioxide (TiO2)/polyvinyl alcohol (PVA) composite for gamma-rays radiation shielding

IOP Conf. Series: Journal of Physics: Conf. Series **1279** (2019) 012019 doi:10.1088/1742-6596/1279/1/012019

Preparation, morphological, and mechanical characterization of titanium dioxide (TiO2)/polyvinyl alcohol (PVA) composite for gamma-rays radiation shielding

R. K. Fakher Alfahed[1, *], Kareem K. Mohammad[1], Munaf S. Majeed[1], Hussain Ali Badran[2], Kamal M. Ali[3], Burak Yahya Kadem[4].

[1]Al-Nahrain University, Al-Nahrain Nano- renewable Energy Research Center, Baghdad, Iraq

[2]Department of Physics, College of Education for Pure Sciences, University of Basrah, Basrah, Iraq.

[3]Department of Physics, College of Education, University of Samarra, Salah Aldeen, Iraq.

[4]Department of Physics, College of Sciences, University of Babylon, Babylon, Iraq.

[*] rrr80kkk@yahoo.com

Abstract. Polyvinyl alcohol (PVA) has been prepared as a films with different volume ratios of titanium dioxide (TiO2). Atomic force microscope (AFM) was used to test morphology and grain size of the specimen surfaces. The results revealed that the surface roughness of specimen decreased with increasing the ratio of TiO2 whereas the grain size was increased. The stress-strain curves for TiO2/PVA composite films with 0%, 0.02%, 0.03%, and 0.04% TiO2 content are characterized. The mechanical performance of the TiO2/PVA composite films was clearly affected according to loaded TiO2 contrast to that of the pure film. Furthermore, the titanium dioxide (TiO2)/polyvinyl alcohol (PVA) composite samples examined as a shielding material of gamma ray. linear attenuation coefficient was measured by using the Cesium-137 (Cs-137) and gamma-ray photons 662 keV as a radioactive source. It was shown that the efficiency of shielding material increased with increasing the loaded amount of TiO2.

1 Introduction

The undesired hazards of X-rays, gamma-rays and neutron which cause great harm to nearby human being can be avoided by using several of shielding materials that have the ability to attenuate or absorb these types of radiations. Materials like lead and other high Z materials are used to attenuate this high-energy radiation. Although, high Z elements do not have the ability to block all types of radiations, especially neutron emissions in space or nuclear laboratories. They are some restricted in this materials applications because of their heavy weight, bulky space, and toxicity [1–3]. Therefore, the lightweight, workability, and its ability to attenuated the radiation, all this properties of filler-reinforced polymer composite which is non-toxic ‘‘lead-free’’ materials make it has a great public interest in many areas such as medical treatment, nuclear plant and mobile nuclear devices. For example, the mixing of ethylene-propylenediene rubber (EPDM)/low density polyethylene (LDPE) with boron carbide is used for neutron shielding widely [4], while in the shielding of against X-ray with the voltage range from 40 to 150 kV bismuth oxide (BiO) nanoparticles blended with polydimethylsiloxane (PDMS) is used [3]. This material is not suitable for a long-term use, because of their poor mechanical strength, low radiation resistance and thermal stability. Epoxy resin owing to containing rich hydrogen atoms are quite effective to decelerate fast and intermediate neutrons [5]. Moreover, the excellent mechanical properties which denoted by its superior solvent and chemical resistance, adhesive strength and good dimensional stability, there for epoxy-based composite for nuclear plants use is more suitable [6, 7]. Therefore, the matrix of epoxy composite that loaded with high concentrations of high-Z fillers is an attractive candidate, for radiation