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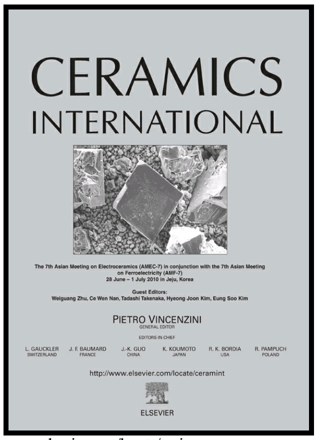

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Polyvinyl alcohol thin film reinforced by green synthesized zirconia nanoparticles

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Abstract
The focus of this work is to prepare polyvinyl alcohol (PVA) thin film reinforced by green synthesized zirconia nanoparticles. In order to do so, firstly, zirconia nanoparticles were synthesized by the rosemary extract-assisted sol-gel process as both template and stabilizing agents. The results showed that the as-obtained sample with zirconium salt to rosemary extract ratio of 1:4 had a semi-spherical morphology with the mean particle size of 12-17 nm. This nanoparticle was added as reinforcement with different ratios to the polyvinyl alcohol matrix. The mechanical property of the as-prepared nanocomposites revealed that the elastic modulus of 1 wt. % ZrO_2-PVA sample was about 5.5 times higher than pure PVA thin film.

Keywords: Zirconia nanoparticles, Nanocomposite, PVA, Mechanical property.

1. Introduction

Polymeric matrix nanocomposites (PMNC) are polymer based composites which have nanosized fillers in their matrixes [1]. Nanofillers modify and improve properties of the polymer such as physical, mechanical and thermal properties [2]. This change in the polymer properties is occurred because of the unique high surface-to-volume ratio of the nanofillers [3]. Polyvinyl alcohol (PVA) is a water-soluble, biodegradable polymer that has exceptional optical and physical properties and chemical resistance resulted in its use in the various applications such as biomedical devices [4], drug delivery [5], membrane technology [6] and fuel cells [7].
One of the main problems in the using of PVA films is the weak mechanical properties as compared to other petroleum-based polymers [8].
In the recent years, two types of nanofillers. i.e. organic types and mineral ones have been used to improve and reinforce the polymer properties.
Among organic nanofillers, CNTs appear to be very effective reinforcement for the preparation of polymer nanocomposites [9]. However, CNTs as nanofillers have drawbacks such as high production costs and difficulty dispersion in polymer matrices due to the hydrophobic nature of them [10]. Also, in the graphene-based polymer nanocomposites, van der Waals interaction between graphene sheets prevent good graphene dispersion in the polymer matrices that causes low compatibility with PVA as a polymeric matrix [11]. Because of this problems, the functionalization of organic nanofillers and derivation of graphene such graphene oxide (GO)/ reduced graphene oxide (RGO), is considered to disperse this kind of nanofillers homogeneously in the hydrophilic PVA matrix [12]. However, functionalization suffers from additional chemical treatment on the primary organic nanofillers [13].
On the other hand, mineral nanofillers include different clays [14], metal nanoparticles (e.g. Ag, Au) and metal oxide nanoparticles (TiO_2, SiO_2, Al_2O_3) is being viewed depend on the final