

## Synthesis and optical properties of PVA/ZrC nanocomposites

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### Abstract

In this work, preparation of PVA/ZrC nanostructures and studying the optical properties to employ in different optical fields. The PVA/ZrC nanostructures were fabricated using casting method. The optical properties were measured at wavelength ranged from 200 nm to 800 nm. Results showed that the absorbance(A) of polymer was rise while the transmittance (T) was reduced with rise in the ZrC NPs ratio. The energy gap( $E_g$ ) was reduced as the ZrC NPs ratio rises. Also, the results of optical properties indicated that the PVA/ZrC nanocomposites have high absorption at UV region.

**Keywords:** PVA; Optical properties; ZrC; Optics fields; Energy gap

### 1. Introduction

The unique and easily adaptable characteristics of polymers and polymer composites open up possibilities for employing these substances in an indefinite number of fields. Among a variety of special features, the simple processing methods and optical characteristics of new compound polymers, create them reliable candidates for different optoelectronic approaches [1]. Polymer nanocomposites have been extensively investigated not for their several fields but to understand their physical characteristics. In light of these studies, it was observed that addition of a small ratio of the nanoparticles to the polymer medium improvement considerable characteristics for numerous fields [2]. Combining materials of organic polymers and inorganic nanosize opens novel fields for the host polymer [3]. The typical advantages of organic polymers materials are flexibility toughness, formability and low density, whereas ceramics materials have good mechanical, optical and thermal characteristics [4]. Polymer substances have enthralled scientists due to they are safe, inexpensive, plentiful, and have eco-sustainable characteristics and wide application in scientific and technical investigating [5]. Polyvinyl alcohol (PVA) is one of polymeric substances that have broad variety of fields. This is mostly because of their excellent optical characteristics, lightweight, excellent mechanical characteristics. PVA has a lot of uses such as adhesives, drug delivery systems coatings, and fuel cells. Owing to the strong inter and intra molecular hydrogen bonds between hydroxyl groups, PVA has a elevated melting point that is close to its decomposition temperature which makes its melt processing very difficult and therefore, PVA has been processed mostly from aqueous solutions [6]. Inorganic substances have valuable characteristics like thermal stability and elevated mechanical strength. Consequently, polymer inorganic hybrids are finding different [7]. There are several studies on PVA-composites materials [8-12]. The present work aims to prepare of PVA/ZrC nanocomposites and studying their optical properties.

### 2. Material and methods

The nanocomposites of polyvinyl alcohol(PVA) with different ratios of zirconium carbide(ZrC) were prepared using casting method. The PVA solution was prepared by dissolving of 1 gm in (30 ml) distilled water. The ZrC NPs were added

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to the PVA solution with concentrations 1.1%, 2.2%, and 3.3%. The optical properties of nanocomposites films were recorded using spectrophotometer (UV-1800<sup>0</sup>A-Shimadzu). The absorption coefficient ( $\alpha$ ) is determined by [13]:

$$\alpha = 2.303 (A/t) \dots\dots\dots (1)$$

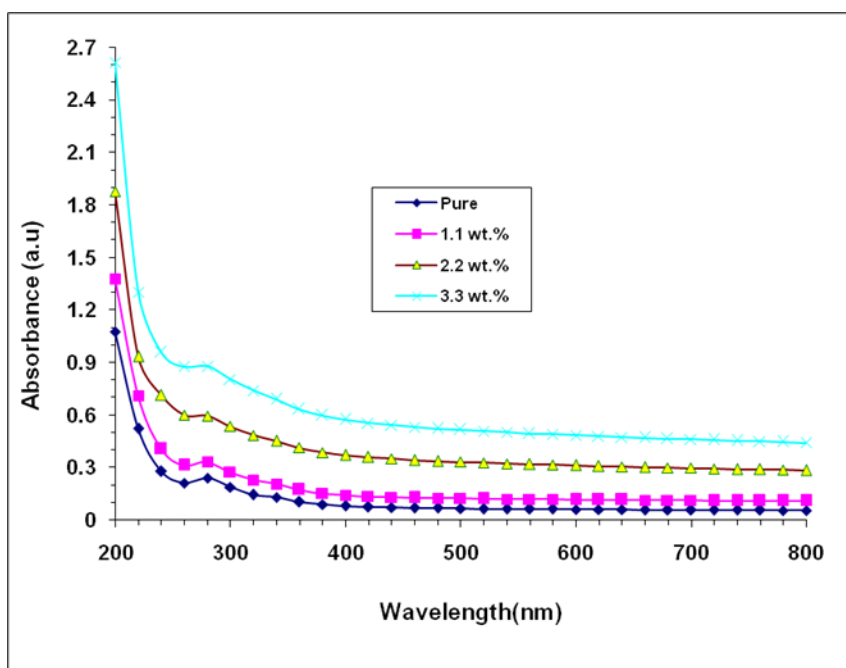
Where A is the absorbance and t is the thickness. The energy gap is given by [14]

$$(\alpha h\nu)^{1/n} = C(h\nu - E_g) \dots\dots\dots (2)$$

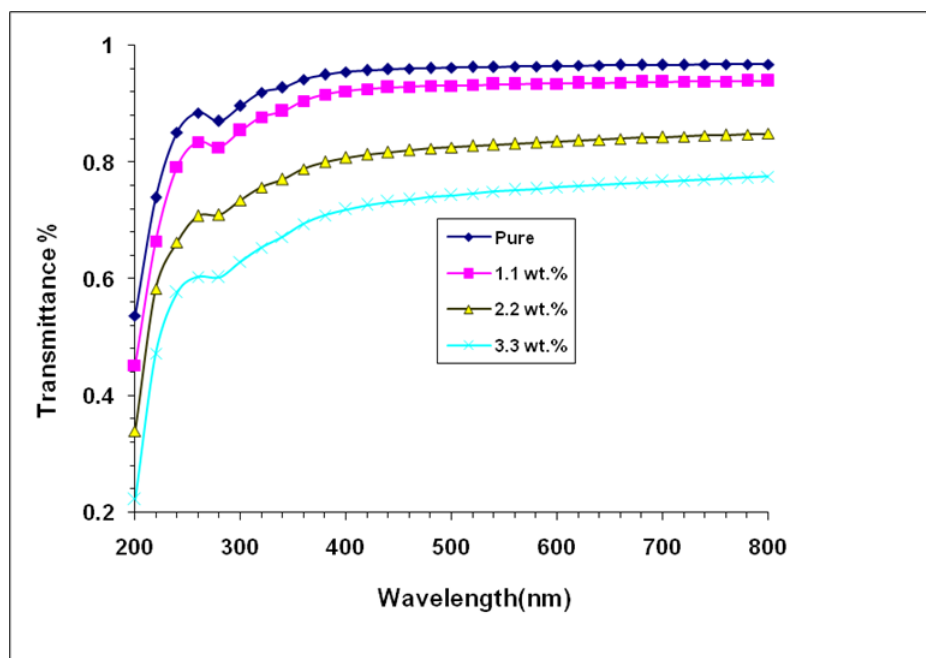
Wherever B is constant,  $h\nu$  is the photon energy,  $E_g$  is the energy gap,  $n = 2$  and  $3$  to allowed and forbidden indirect transitions.

### 3. Results and discussion

Figure 1 and Figure 2 represent of the absorption and transmission spectra of PVA/ZrC nanocomposites respectively. The absorption intensity of PVA/ZrC nanocomposites increases while the transmission reduces when the ZrC NPs content rises, this behavior due to increase in the charge carriers density lead to increase in the absorbance values [15-20], hence the transmittance will reduce.

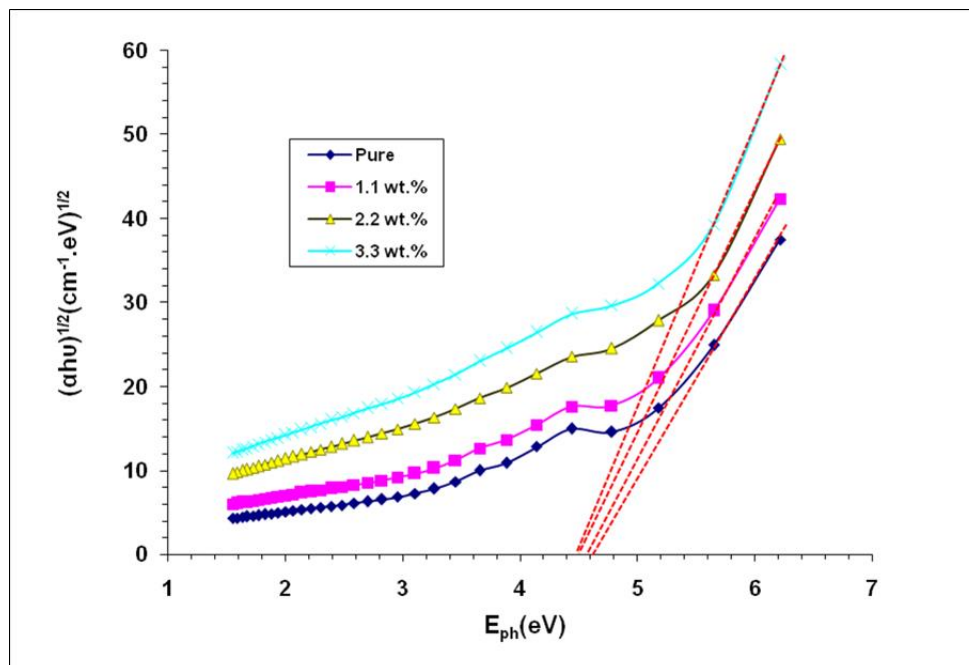


**Figure 1** Absorption spectra of PVA/ZrC nanocomposites

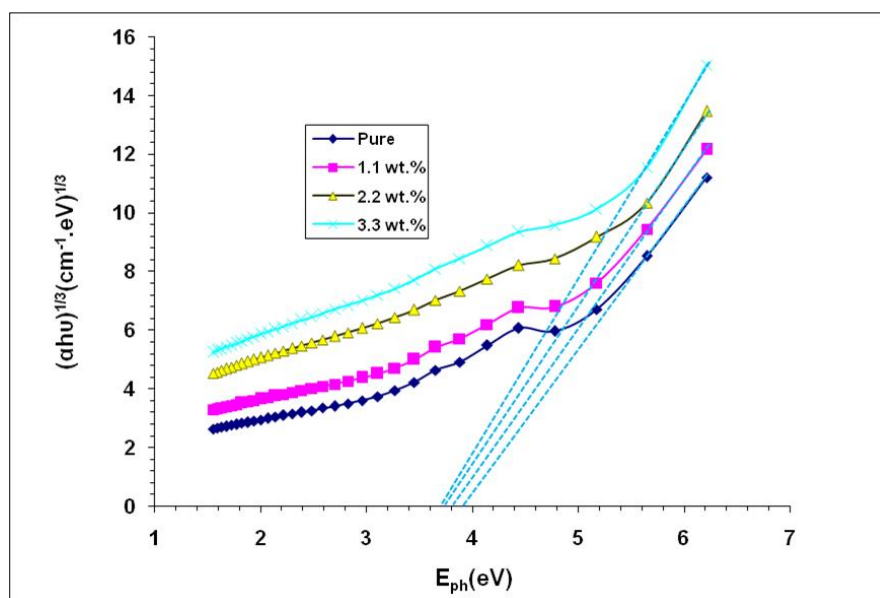


**Figure 2** Transmission spectra of PVA/ZrC nanocomposites

Figures 3 and 4 show the values of energies gaps for allowed and forbidden indirect transitions of PVA/ZrC nanocomposites respectively. As shown in these figures, the energies gaps for allowed and forbidden indirect transitions of PVA reduce with increase in the ZrC NPs content. The reduce in energy gap values is suggested to increase with a disturbance degree to create the localized level in the nanocomposites structures lead to decrease the distant between the conduction band and valance band, hence the energy gap decreases[21-25].



**Figure 3** Values of energies gaps for allowed indirect transition of PVA/ZrC nanocomposites



**Figure 4** Values of energies gaps for forbidden indirect transition of PVA/ZrC nanocomposites

#### 4. Conclusion

The present work includes a preparation of PVA/ZrC nanostructures and investigating their optical properties to use in various optical fields. Results showed that the PVA/ZrC nanocomposites have high absorption at UV region. The absorbance of PVA was rise while the transmittance was reduced with rise in the ZrC NPs ratio. The energy gap of PVA was reduced as the ZrC NPs ratio rises which make it can be suitable for different optical fields.

#### Compliance with ethical standards

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##### Disclosure of conflict of interest

No conflict of interest.

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