



# Thermal, optical features, and dielectric relaxations in Zn-Pb-O/PVA-PEO nanocomposites for UV-shielding and energy storage

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## ABSTRACT

This study reports the preparation of nanocomposites based on Zn-Pb-O NPs and PVA-PEO films. TEM, XRD, SEM, and EDX were utilized to investigate the morphology, crystal structure, crystallinity, filler distribution, and chemical composition. The results revealed that spherical Zn-Pb-O NPs of 27.5 nm in size and with a mixed wurtzite and orthorhombic structure were dispersed uniformly inside the PVA-PEO, decreasing its crystallinity. FTIR showed that the blend's reactive groups interacted physically with Zn-Pb-O NPs. The TGA-DTA and DSC analyses exhibited a reasonable thermal stability and revealed the transition temperatures. The UV-vis study showed a decrease in the transmittance and an increase in the absorption index in the UV regime. The bandgaps of the blend 4.4–5.4 eV decreased to 1.6–4.05 eV with increasing filler level. The dielectric parameters (dielectric constant, loss factor, conductivity, and dielectric moduli) showed a strong dependence on the applied field frequency and filler content. The analyses of the Argand plot showed two relaxation processes of non-Debye nature. This study revealed that ZnPbO/PVA-PEO films exhibit thermal stability, an improved semiconductive nature, an improved dielectric constant with small loss, and improved energy density and conductivity. They are suitable for various photoelectronic (UV shielding and IR sensing) and energy storage applications.

## Introduction

Currently, there is a great interest in developing multi-functional and cost-effective polymeric compounds and membranes with adjustable features for industrial applications, such as electrical devices, energy storage, optoelectronics, wastewater treatment, and biomedical areas [1–10]. Blending and nanocomposition (a polymer or blend contains nanoscale additives) approaches can be employed to ameliorate the polymer's properties without resorting to complex chemical methods [3,11,12]. These additives represent the interconnecting network among the chains or components of the polymeric matrix. Compared with the classical dielectric materials, the polymeric dielectric nanocomposites distinguish by the flexibility, ease of processing, low density, and high electric breakdown strength [13].

Among the water-soluble polymers (WSP), the poly(ethylene oxide) (PEO,  $(\text{CH}_2\text{CH}_2\text{O})_n$ ) is a linear and non-toxic polymer produced by the heterogeneous polymerization of the ethylene oxide. PEO is a semi-crystalline thermoplastic polymer with excellent hydrophilicity, swelling and gelling characterizations, and viscosity, where its ether linkage ( $-\ddot{\text{O}}-$ ) provides a chain mobility and

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