Influence of Cr_2O_3 nanoparticles on the physical properties of polyvinyl alcohol

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Abstract: Nano-sized chromium oxide (Cr_2O_3) was synthesized by sol-gel method and mixed with polyvinyl alcohol (PVA) to produce nanocomposite films. Scanning electron microscopy (SEM) was used to observe the morphology and dispersion of Cr_2O_3 on the surface of the PVA films. X-ray diffraction (XRD) was performed on nano-sized Cr_2O_3, pure PVA, and Cr_2O_3/PVA composites. Based on the results of both XRD and high-resolution transmission electron microscopy (HR-TEM), the average particle size of the Cr_2O_3 was ~46nm. Differential scanning calorimetry (DSC) showed that the thermal stability and degree of crystallinity of the PVA were reinforced by the addition of Cr_2O_3 nanoparticles. The absorbance and extinction coefficients of the composites were studied in the UV-vis range and compared with those of pure PVA. The optical energy band gap, E_g , was calculated. Dielectric constant, ε' , dielectric loss modulus, M'' , and ac conductivity, σ_{ac} , of all samples were measured within temperature and frequency ranges of 300–468 K and 10kHz-2MHz, respectively. According to the frequency and temperature dependence of the dielectric loss modulus, M'' , the observed a-relaxation peak was due to the micro-Brownian motion of the polymer main chains. The behavior of σ_{ac} (f) for the composite films indicated that the conduction mechanism was correlated barrier hopping (CBH). The results of this work were discussed and compared with those of previous studies of PVA composites.