Development of Novel Nanocomposite Membrane for Energy Conversion Cells

Shimaa Ibrahim Abou ElAzm Elkalashy

Solid polymer electrolyte (SPE) is synthesized using solution casting technique. The SPE uses poly (vinyle alcohol) PVA as a host matrix, solid acid NaHSO4, ethylene carbonate (EC) as plasticizer and (Si) as filler. The XRD illustrated the addition of EC reduces the degree of crystalinity of NaHSO4 where the addition of Si resulted in the formation of new structure (SiOS). In addition, Fourier transform infrared spectroscopy (FTIR) spectra show the occurrence of complexation and interaction among the components. Scanning electron microscopy (SEM) images show that change morphology of solid polymer electrolyte. The obtained bulk conductivity illustrates an improvement with EC concentration to characteristic concentration 9.9 wt. %EC, In addition it increases with temperature obeying Arrhenius law. This can be attributed to an increase in amorphous content which enhances the segmental flexibility of polymeric chains and the disordered structure of the electrolyte.A solid state magnesium battery is fabricated and characterized. A cell with the configuration Mg/ ((PVA□ 0.5 NaHSO4)/ 9.9 wt. % EC) /MnO2 gives a real capacity 249 mAh/g and has an internal resistance ≈165 Ω and cell with the configuration Mg/ ((PVA□ 0.5 NaHSO4): 9.9 wt. % EC/ 3.75 9 wt. % Si) /FeS2 gives a real capacity 112 mAh/g and has an internal resistance ≈160 Ω. The electrodes degradation after discharge was characterized by XRD analysis.polymer samples based on metal chlorides and polyvinyl alcohol (PVA)for the electronic applications. PVA/CoCl2, PVA/NiCl2 and PVA/MnCl2have been prepared by means of in situ synthesis via the solvent casttechnique. The prepared nanocomposite polymer samples withconcentrations (41.6, 32.2, 19.2, 4.5 wt%) of CoCl2 , NiCl2 and (37.2,28.3, 16.5, 3.8 wt%) of MnCl2 have been characterized using varioustechniques, X-ray diffraction (XRD), the differential scanningcalorimetric (DSC) and the scanning electron microscope (SEM). DCand AC conductivities are examined at different temperatures andfrequencies; also optical absorption in UV-Visible range was studied.The growth of metal chloride crystallites in the polymer matrix innanoscale for samples of higher contents of metal chlorides has beenobserved Using XRD and SEM studies. Furthermore, the intensity ofPVA characterizing peak has decreased while its broadness has beenincreased which revealed that the amorphisity of the polymer matrix hasincreased.The temperature dependence of DC electrical conductivity for allinvestigated samples has been studied between 303 and 443 K. Theresults showed that the electrical conduction is thermal activated processobeying Arrhenius relation. The activation energy was calculated andfound

in the range from 0.64 to 0.26 eV for all investigated samples.The AC conductivity (σac), dielectric constant (ε’), dielectric loss(ε’’) and loss tangent (tanδ) were performed in the temperature range303-443 K over the frequency range 100 Hz-100 KHz. The frequencyAbstractdependence of the AC conductivity shows that σac increases withincreasing frequency for all investigated samples. The AC conductivityobeyed the ωs power law. The values of the power s of all samples havebeen extracted at different temperatures which suggest the hopping andtunneling conduction mechanisms. The frequency and temperaturedependence of the dielectric constant (ε’), dielectric loss (ε’’) and losstangent (tan □) have been studied. The general behavior showed that ε’,ε’’ and tan □ decreased with increasing frequency for all investigatedsamples obeying Debye dispersion equations. The dependence of thedielectric constant (ε’) on temperature shows two broad peaks related toα relaxation processes.The optical absorption spectra were performed in the wavelengthrang (200-900 nm) for all mentioned samples. The absorptionmechanism is due to allowed direct and indirect transitions with oneoptical band gap for composites contained MnCl2 and two band gaps forcomposites contained CoCl2 and NiCl2. Co+2 ions are present in mixedoctahedral and tetrahedral form while Ni+2 ions are present in octahedralform in the polymeric matrix. The optical band gap, absorption edge andUrbach energy were evaluated and their values change with the changein both particle size of metal chlorides and their concentrations insidethe polymer matrix.