RESEARCHS ABOUT THE RECYCLING OF MOBILE PHONE

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Abstract

This project aims to recycle the active mass from a used battery from a mobile phone (marked with BT) by embedding in sodium phosphate diacid, characterizing newly prepared materials and testing their electrochemical performance as electrode materials for batteries with lithium. Samples with the composition of xBT · (100-x) NaH2PO4 were prepared by the method of melting the melt where x = 0 - 30% by mass of BT using as raw materials the black powder recovered from a disassembled telephone battery and sodium diacid phosphate. The prepared materials were investigated by X-ray diffraction (XRD), spectroscopy: Infrared (IR), UltraViolet-Visible (UV-Vis), Electronic Spin Resonance (RES) and Cyclic Voltametry (VC) measurements. X-ray scattering diffractograms indicate for samples up to 10% a glass with an amorphous structure, while for samples with a higher content of the active mass from the used battery, a vitroceramic is obtained which contains as crystalline phases phosphates of metal ions and diffraction peaks. The analysis of IR data shows that the intensity of the absorption bands characteristic of phosphate structural units increases by doping. UV-Vis and RES data indicate the presence of ions in recycled materials. The values of the optical gap energy, for direct transitions have values below 3eV which indicates that the materials have semiconductor properties while for indirect transitions the gap energies are around 3.5eV with a maximum for the sample of 5%.

Cyclic voltammograms recorded for the prepared material with the composition x = 25% mass BT as working electrode in a lithium ion electrolyte solution indicate that it has the highest current density which provides an alternative for new battery applications. lithium-based.

Introduction

The lithium recycling from spent mobile phone batteries requires the integrate an eco-innovative technology with reduced costs and the energetic efficiency [1, 2].

The aim of this paper is: i) to recycle the active mass from a spent mobile phone (noted with BT) by the incorporation in a glassy former, respectively the sodium diacide phosphate, NaH_2PO_4; ii) to characterize new recycled materials and iii) to test their electrochemical performances as a new electrode material for the applications in the lithium-ion batteries. Samples in the $xBT\cdot(100-x)NaH_2PO_4$ composition where x = 0 – 30 weight % BT were prepared by the melt - queching method using as raw materials the black powder recovered from the disassembled phone battery and sodium diacide phosphate powder.

Expermental procedure and Methods

The spent phone battery was disassembled with a nail and a hammer. An active mass from spent phone battery (black powder, BT) and NaH_2PO_4 powder was used as starting materials. The substances according to the predetermined formula, $xBT\cdot(100-x)NaH_2PO_4$ were weighed on the analytical balance. The mixture was placed in a ceramic crucible. The crucibles with the mixture were placed in an electric oven set at 700 °C. After 10 minutes crucible with the melt was removed from the oven and overturned on a stainless steel plate directly at room temperature.

The prepared materials were characterized by the analysis of X-ray diffraction (XRD), Infrared (IR), UltraViolet-Visible (UV-Vis) and Electronic Paramagnetic Resonance (EPR) spectroscopy. The electrochemical performance of recycled materials as working electrodes on the lithium battery, was investigated by measurements of cyclic voltammetry. The electrochemical properties of the samples were tested by cyclic voltammetry measurements using an AUTOLAB PGSTAT 302N potentiostat / galvanostat (EcoChemie, The Netherlands) and NOVA 1.11 software. To simulate the behavior of the electrode in the car battery was used an electrochemical cell with three electrodes: the reference electrode (calomel electrode), the working electrode (recycled sample), counter electrode (platinum electrode) which are all immersed in a solution of lithium ions.

Results and discussion

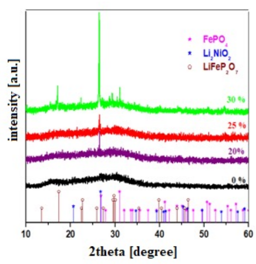


Figure 1. X-ray diffractograms of the vitreous system in the $xBT\cdot(100-x)NaH_2PO_4$ composition where x = 0 – 30% BT.

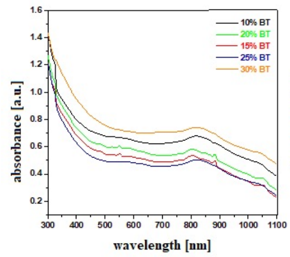


Figure 2. UV-VIS spectra of the recycled materials in the $xBT\cdot(100-x)NaH_2PO_4$ composition where x = 0 – 30% BT.

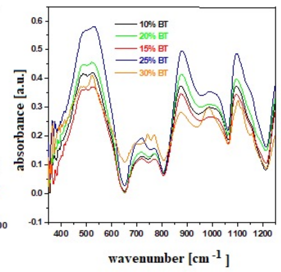


Figure 3. IR spectra of the recycled materials in the $xBT\cdot(100-x)NaH_2PO_4$ composition where x = 10 – 30% BT.

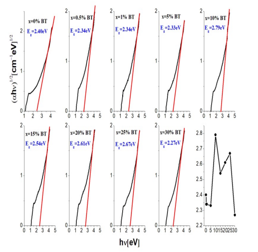
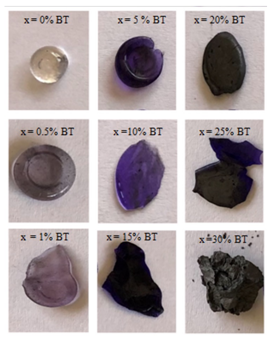


Figure 4. Dependence $(\alpha h\nu)^{1/2}$ as function of hν. Extrapolation of the optical gap energy, Eg and the compositional evolution of the optical gap energy values, Eg for the recycled system.



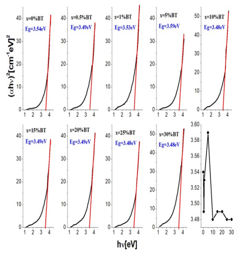


Figure 5. Dependence $(\alpha h\nu)^2$ as function of hν. Extrapolation of the optical gap energy, Eg and the compositional evolution of the optical gap energy values, Eg for the recycled system.

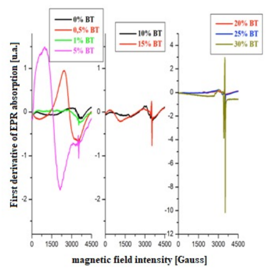


Figure 6. EPR spectra of the recycled materials in the $xBT\cdot(100-x)NaH_2PO_4$ composition where x = 0 – 30% BT.

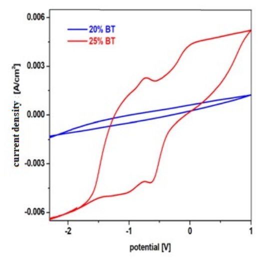


Figure 7. Cyclic voltamograms of electrode materials in the $xBT\cdot(100-x)NaH_2PO_4$ composition where x = 20 and 25% BT.

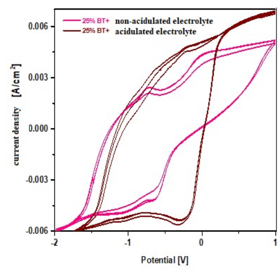


Figure 8. Cyclic voltamograms scanned after three cycles for electrode materials of the recycled materials in the $xBT\cdot(100-x)NaH_2PO_4$ composition where x = 25 % BT using non-acidulated and acidulated lithium ion solution.

Conclusions

Samples in the $xBT\cdot(100-x)NaH_2PO_4$ composition where x = 0 – 30 weight % BT were prepared by an eco-innovative method, namely melt-queching method, using as raw materials the spent active mass of the phone battery. Recycled materials by the incorporation in the phosphate host network were investigated by XRD, FTIR, UVVIS, EPR and measurements of cyclic voltammetry. The analysis of X-ray patterns indicates for the samples with a content of x ≤ 15 % mass BT an amorphous structure while at higher dopant levels vitroceramics with different crystalline phases were evidenced. IR data indicate the formation of $[PO_4]$, $[NiO_n]$ and $[FeO_n]$ structural units due to the excess oxygen. UV-Vis and EPR spectra suggest the presence of Fe^{+3} and Fe^{+2} ions in the host matrix. EPR data show the resonance lines characteristic of Ni^{+2} and Fe^{+3} ions. The values of the optical gap energy for direct transitions are lower than 3eV, which indicates semiconductor behaviour for all studied samples. Cyclic voltammetry measurements indicate clearly superior electrochemical performance for the sample doped with x = 25% BT mass which can be recommended as new suitable electrode for the lithium-ion battery.

Bibliography

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