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Advanced method for reuse of Li-ion batteries and Analysis by new designed electronic circuit

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Abstract: *The development process of the lithium-ion batteries portable combined chemical treatment with lithium-ion battery, designed electronic in new steps to the process of designing electronic circuit fresh and new idea also intended to restore the use of the battery again and it is not the injection of cobalt, nickel and other ions, but the injection of all other battery components, especially lithium and interest for the Battery is the re-injection of the same components, and was the focus of the research work in the development of chemically-step process in the new electronic circuit designed and inexpensive materials extracted from the lithium-ion batteries expired. Was the purpose of this paper is the interest of battery components, which contain substances pole. To produce a composite-ion was proof of the feasibility of the main objective. To get to the proper voltage and comparing the effort Original has been done successfully by taking different concentrations and injected in a mogul's circuit.*

Keywords: *Lithium-ion batteries, electronic circuit.spent, cobalt- lithium composite, chemically Treatment*

I. Introduction

Since the 1990s, primary lithium and lithium-ion batteries have become the power supply of choice in many consumers, industrial and military applications due to their advantages in terms of energy density over other battery technologies. A considerable research effort has been invested in developing inherently safer chemistries and the development of more effective thermal management systems and protection(1,2) devices The aim of this paper is to review the safety characteristics of commercial primary lithium and lithium-ion battery technologies, focusing on side reactions and thermal behaviours that could compromise safety during operation. Safety mechanisms and tests that have been designed to evaluate battery performance during normal use and abuse circumstances are subsequently reviewed in light of experimental evidence available in the open literature. Hazards associated with primary lithium and lithium-ion cells have materialised not only during use at the intended application, but also during transport and storage of new and used battery packs; or when end-of-life batteries undergo treatment for recycling two Recover marketable materials. Within the last two decades the requirements for batteries as mobile energy sources have constantly increased and have become more and more to meet the requirements brought by legislation. A number of recent incidents during transport, storage and recycling operations described in the news accounts have also been reviewed. Although definitive evidence on the actual mechanism initiating the events is often lacking, incidents can at times be linked to incorrect handling, storage and packaging practices that may lead to mechanical damage, water ingress, and/or internal or external short-circuit of charged complex. The trend towards improved mobility in the rapidly developing fields of portable computer, communication, video and audio technology has strongly pushed the development of batteries. As supplier of the communications technology industry the battery industry shows an annual double-digit growth rate (3) .At the beginning of the 1990s Li-ion batteries have been regarded as the most promising energy sources for mobile applications. This has been proven true today; for instance, Li-ion batteries have totally replaced NiCd batteries as well as NiMH batteries in mobile phones as they offer a lot of advantages compared to other rechargeable battery systems, such as high operating voltage, high specific energy and long life-time. The widespread and constantly increasing use of Li-ion batteries also leads to an increased battery scrap generation (in both production as a well as end-of-life), which has to be recycled with regard to environmental and economical sustainability. Ideally a closed-loop recycling should allow for returning back the recycling products to the production of new batteries. Li-ion batteries contain high amounts of valuable metals, such as aluminum, iron, copper, lithium, cobalt, nickel and manganese. Metal is cobalt, which is contained in the battery electrode material. Hence the cobalt recovery has a strong influence on the economic efficiency of a suitable battery recycling process. In 2006 the United States and Europe had the highest proportion, 28.4% respectively 27.2%, of the worldwide Li-ion battery consumption but their proportion of the worldwide Li-ion battery production was only 0.4% and 2.0%, respectively. More than 90% of Li-ion battery cells were produced in Japan, South Korea and China. With 40% Japan was the country with the highest Li-ion battery cell production since the mid-1990s the usage of Li-ion batteries (4) has strongly increased. Today's strong market position of Li-ion batteries is reflected by the sales figures. In 2008 more than 3 billion Li-ion battery cells (5) were sold. In the EU sales in 2007 were three and a half times higher than in 2002 .Nevertheless the absolute return flow of spent Li-ion batteries is still low and the collection rate in 2007 was only about 3%. On the one hand this is mainly caused by the long life-time of Li-ion batteries and on the other hand by the end-consumer.

Behavior, who usually dispose of spent batteries for recycling only after several years. In Germany Li-ion batteries had a market share of more than 50% for the first time in 2008, but here the collection rate of approximately 9% is comparatively low. In spite of the currently low collection rates forecasts show that sales figures will continue. Lithium primary batteries have been available on the market for about 25 years, while lithium-ion secondary batteries or storage batteries have less than 10 years of commercial development(6) . A lithium-ion secondary battery comprises a cathode, an anode, organic electrolyte, and a separator. Nowadays, LiCoO2, LiMn2O4, LiNiO2 or related oxides are used as cathode materials for almost all commercialized lithium-ion secondary batteries, and these are especially applied for mobile phones, personal computers, video-cameras, etc. due to themany advantages of lithium-ion secondary batteries, such as: (a) high energy density, (b) high battery voltage, (c) long charging–discharging cycle and (d) large temperature range(7) . Since the available dumping sites for disposal are limited and very costly, effective methods and low costs are the objectives in separating and recovering the spent lithium-ion secondary batteries (8). It will be very interesting to be able to recycle and regenerate the major metal values of spent batteries, in order to benefit the economy, and at the same time, reduce environmental pollution. Some hydrometallurgical and hydrometallurgical processes for the recycling of spent lithium-ion secondary batteries have already been reported or patented (9), but most of these are in the pilot or laboratory testing phase. In addition, using recycled metal value from spent lithium-ion secondary batteries to prepare LiCoO2, LiMn2O4, LiNiO2 and related oxides electrode materials has been investigated(10) , and the current status of the recycling technologies of spent lithium-ion batteries have been reviewed(11) by the overall recycling technology consists of both physical and chemical processes. The physical process, such as dismantling, crushing, sieving, etc. is developed in order to separate the cathode materials from other substances. The chemical process mainly uses diluted acid to dissolve the cathode material, after which a solvent extraction, precipitation method, etc. are operated to separate the metal value. It is obvious that this step depends on the concentration and categories of leaching, the extraction and precipitation of reagents, and it is necessary to combine several techniques to recover each metal value. The chemical process of the recovery technology for the spent lithium-ion secondary batteries. Up until now, most of the research works in the chemical process cannot fulfill the complete separation of each metal value from the cathode materials. Thus, it is important to develop a simple and environmentally acceptable recycling process to recover as much of the valuable metals as possible. Experiments of leaching Co, Mn, Ni and Li contained in the cathode material of the batteries have been conducted on dissolving in acid solution, neutralization, precipitation, oxidation reduction and filtering, and various separation procedures using different oxidizing reagents, etc. The amount of oxidizing reagent, temperature, etc.was also investigated in the recovery material process of the mixture.

II. Experimental:

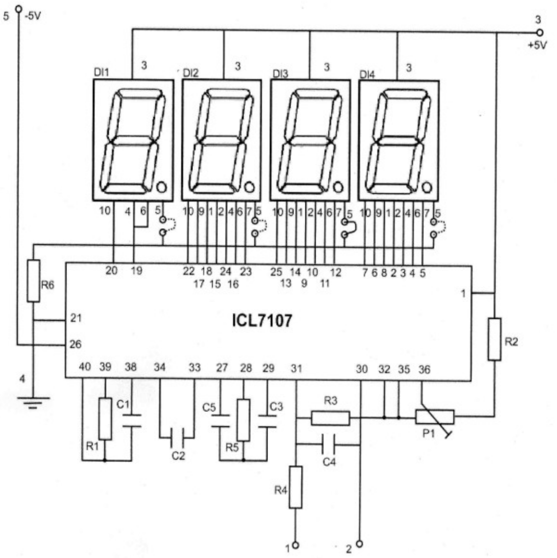


Fig. (1) Schematic diagram of New designed electronic circuit Connected to the Li-ion battery to measure the electric Potential.

Fig (2) new designed electronic circuit connected to the Li-ion battery to Measure the potential.

2.1. Designing electronic cell.

In Fig. (1): Schematic diagram of New designed electronic circuit Connected to the Li-ion battery to measure the electric Potential.

Fig (2): New designed electronic circuit connected to the Li-ion battery to Measure the potential.

2.2. Synthesized Lithium–iron oxide

Lithium–iron oxide Li–Fe–O was synthesized by solid state reaction between Li_2CO_3 and Fe_2O_3. The sample was characterized by X-ray powder diffraction. The XRD patterns showed well defined reflections corresponding fig (3) to α-$LiFeO_2$ and the spinel $LiFe_5O_8$ in a molar ratio of 9:1. The material was tested as alternative anode for lithium-ion batteries (12).

2.3. Manufacturing of $LiFePO_4$

In the charged state, the lithium atoms are located at the anode, and upon discharged flow through the electrolyte to the cathode, the reaction occurring at the anode during discharged. Li2CO$_3$, lithium carbonate, is used to make $LiFePO_4$. The quantity was estimated to 0.23 g Li2CO$_3$ per gram $LiFePO_4$, by stoichiometric calculation. TPP (tetrakisphenylporphyrin) is electrochemically stable up to 4.9V. The TPP (tetrakisphenylporphyrin) -containing display improved thermal stability compared with TPP-free electrolytes. The addition of 3% TPP to the solution of lithium. Fig (3): Shown that XRD patterns of Li–Fe–O based electrode .Fig (4): Electron micrographl ectrolytes s of cathodes prepared at $LiFePO_4$.

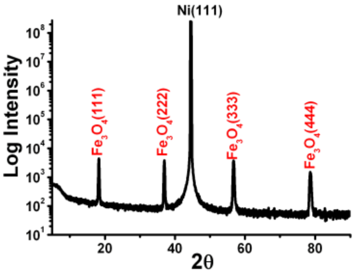


Fig. 3. XRD patterns of Li–Fe–O based electrode

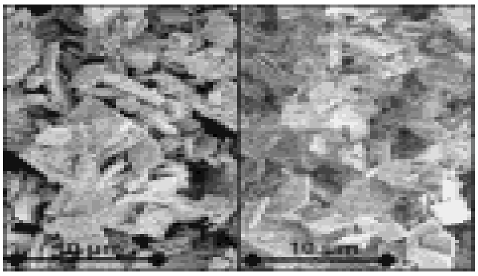


Fig (4): Electron micrographs of cathodes prepared at: (a) $LiFePO_4$

2.4. Mechanism of lithium iron oxide:

$$0.5Li_2CO_3 + 0.9FeO + 0.1Mg(OH)_2 + (NH_4)_2HPO_4 \rightarrow LiFe_{0.9}Mg_{0.1}PO_4 + 0.5CO_2 + 2NH_3 + 1.6H_2O$$

III. Results and discussion

3.1. Reuse of Li- ion battery by injection:

As the Li-ion battery injected by 10 ml of the prepared solution of LiFePO4 and TPP, (triphenylphosphate) and measuring the potential. Study different parameters.

3.2. How to calculate battery Run-Injection?

To calculate the time of injection in the battery, it is assumed that we are using battery-consuming and we did circuit simplified but new in the idea where it came from us this new idea of what we are going through of the economy is very bad and also to environmental pollutants harmful to our health so we neighborhoods battery old dumped rubbish and re-used again and was injected the same cathode electrolyte original battery in them and in certain concentrations and taking the pulse at the beginning of the injection and calculate the voltage in every step to make sure the high voltage up to the effort required to run and compared the original effort of the battery and therefore has been the expense of some of the parameters**.**

3.3-Duration time

3.3.1-Effect of duration time

The effect of duration time on a sheet to give to number of injection, after each hour. Trying to get times worked in hours and mins, from a given start time to a given finished time. I would like inject after 5, 10, 15, at 60min, or 1hour. In the same time determine the voltage and record. The duration time shown the relation ship between times injections against voltage in the fig (5) show the duration time increase to increase the voltage at reached the voltage equal to 2.998v. After 60min the voltage start decreasing gradient at a constant temperature 25^{0}C.

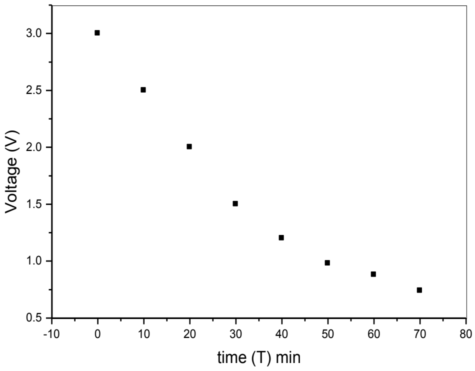


Fig (5): effect of duration time and voltage

3.4. Effect of pH

3.4.1. Effect of the pH on the ionic transfer between the electrolyte solutions. The effect of the pH on the ionic transfer of ions of lithium at the interface between the electrolyte solutions (ITIES) was investigated by a simple analysis method. Fig (6), .Show the relation between the pH against the sensitivity of potential.

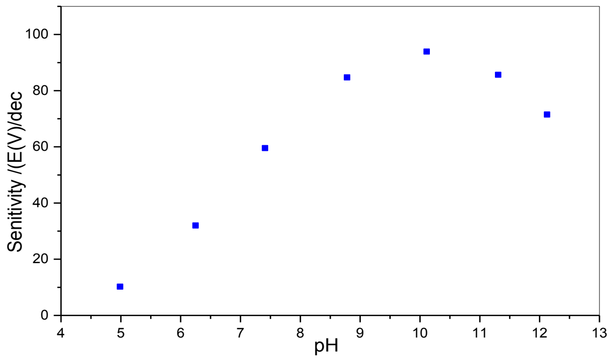


Fig.6. Effect of the pH on the potentiometric response of injected Li ion t

3.5. Relationship between the voltage, concentration and duration time

The concentration of lithium iron oxide as electrolyte solution increased with increase the voltage reached at 2.998V with increase the duration time study at 24 day. The charges start decrease and the voltage decreasing and reached at zero. Plot 3D graphic between the voltage, concentration and duration time Fig. (7). Show that the relation between three parameters and the zone represent amount of lithium in suitable injection. Increasing pH due to increase the sensitivity /E (V) increase and reached at 98%.

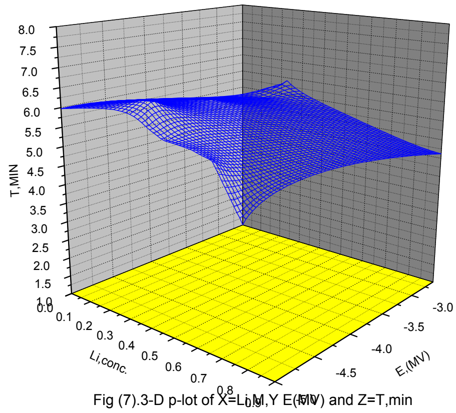


Fig (7).3-D p-lot of X=Li,M,Y E(MV) and Z=T,min

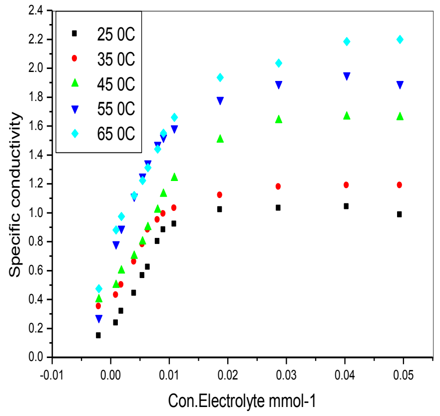
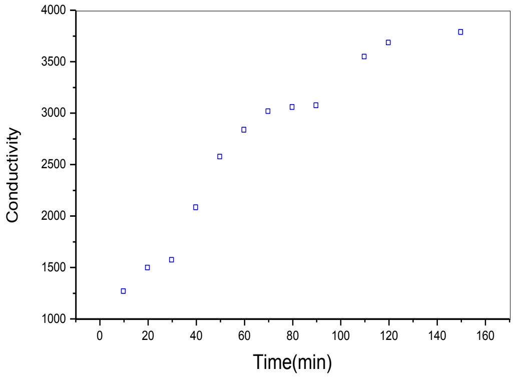
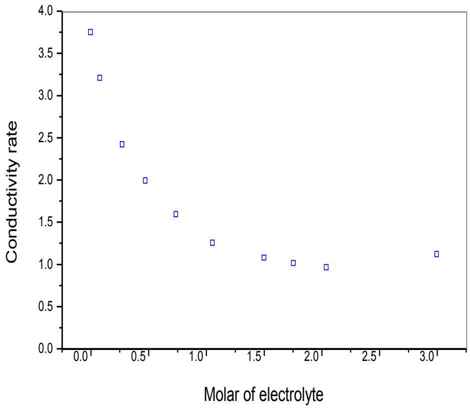


Fig.8. Variations of. Temperature of the electrical conductivity for the system LiFeO4



Fig(9): Effect of the time and Conductivity for electrolyte Battery



Fig(10),. Effect of Molar concentration of electrolyte against Conductivity rate

3.6. General overview of Li-ion battery chemistries

There is also a potential risk of electrolyte. A Li-ion battery consists of a positive electrode (cathode) and a negative electrode (anode), both of which are the source of the electrochemical reaction. The cathodes are immersed in an electrolyte medium, which is a solution containing dissociated salts to ensure the ion transfer between the discharges; the lithium is extracted from the anode and inserted onto the cathode. When the battery charges, the reverse process occurs. Overcharging will supersaturate the lithium cobalt oxide, leading to the production of lithium oxide and often to uncontrolled, highly energetic reactions an empirical equation**.**

3.7. Empirical equation

A new semi-empirical equation for the dependence of transference numbers upon concentration is reported. It is a simple equation applicable to many electrolytes of different stoichiometry $^{(13)}$ over large molality ranges. The equation for each electrolyte is characterized by four parameters, one of them (Ji) being the transference number at infinite dilution, another two (D i, L i) lacking physical meaning, and the fourth being an integer or semi-integer fixed parameter (Pi ---- 1/2, 1, 3/2). For some electrolytes, the last parameter can be different for cation and anion. An apparent incoherence of the proposed equation has been solved by using Taylor series and also by non-linear regression analysis followed by smoothing. As a consequence of this, the equation now reported is of dual application for either the cation or the anion transference numbers. Some applications of the new equation to obtain hydration and water transfercnce limiting numbers. $LiFeO_4$ as electrolyte relatively high concentration, the transference number of $LiFeO_4$ recovered by equation [1] using the Jc and Dc values obtained by the e.m.f, method within 0.0024 over the entire range of concentration up to 1.0 mol kg -l. Similarly for LiCI- $^{(14),}$ that equation is fulfilled in the range up to 3 mol 1- ~ with a maximum error of 0.0017.

$$t_c = \frac{j_c}{1 + D_e\sqrt{m}} - L_c m^{pc} \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \text{(1)}$$

This semi-empirical procedure has been employed many years ago, for instance to extend the application range Furthermore, since of Debye-Hiickel's(15-17) equation for the variation of activity coefficient with ionic strength in most of the experimental data of transference numbers collected in the concentration is expressed in molality, we have selected this form to express the concentration. Where m=Electrolyte Molality Jc, De and L c are the adjustable parameters of this equation and, generally,

$$\lim_{m\to 0} t_c = j_c = t_c^{\,0} \text{ ....} \quad (2)$$

t ° being the cation transference number at infinite dilution. Thus, the fit can also be accomplished to Eq. (2) by setting Jc equal to the value of the limiting transference number according to Eq. (2).empirical formula depends on temperature on rates reaction. Fig [8]. An exponential dependence on temperature of the rate constant k. In the equation, A is the pre exponential factor, which is almost independent of temperature (temperature dependence is slight and can be conveniently ignored). E_a is known as the energy of activation. The logarithmic form of the Arrhenius equation represents a linear relation.

IV. Conclusions

The results obtained in this work confirmed that the selectivity and the reuse of spent Li-ion battery via injection the battery by certain chemically compounds give a good result for reusing this type of battery and analyzed by a new electronic circuit.

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