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ELECTRODEPOSITION STUDY OF ALLOYS FOR SOLAR ENERGY, CORROSION RESISTANCE, AND BATTERY APPLICATIONS

by

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Abstract

Copper zinc tin sulfide (CZTS) compound is one of the alloys which has significantly caught the attention of a considerable number of researchers since the beginning of the century. Consequently, academic laboratories started investigating the alloy in-depth with its various combination due to its valuable applications with high potential usage. The CZTS alloy has a high tendency to replace the current copper indium gallium selenide (CIGS) thin-film solar cell system due to scarcity of CIGS components, and toxic manufacturing-procedures comparing to CZTS. Nevertheless, CZTS is a new studied compound with very low photovoltaic empirical efficiency and an inadequate understanding of its chemical reaction behavior. But, CZTS has high theoretical potential applications due to its superb theoretical photovoltaic properties such as bandgap. Additionally, there are multiple and great properties for Cu, CuZn, CuSn, SnZn, CuZnSn combination alloys as well which will favor them to be used in different applications. For example, brass and bronze have many advantages such as corrosion resistance, strength, more ductile, high wear-resistance, and better appearance. Plus, a thin film of copper over carbon alloy has great application as a thin-film battery electrode due to its ability to store energy. In this study, the behavior of the copper, zinc, tin, and their combination solutions electrodeposited over carbon substrate has been studied with a purpose to have a better understanding of the element behavior during electrodeposition process which would get us a better understanding of the resulted compositions. The study has been done using the electrodeposition method because of its high cost-effectiveness, easiness in manufacturing, and rapid results comparing to all other methods. As a start, equimolar solutions have been stabilized under similar environmental conditions which will make the behavior of the elements as a major factor in the yielded composition. Also, the electrical conductivity of the engineered stable solutions has been examined with varying pH. Then, each solution has been examined using cyclic voltammetry (CV) experiments. Finally, the samples result from constant deposition have been inspected with SEM, EDS, and XRD devices to determine the quality of the electrodeposited elements, their presence, and amount. In this study, it was found that the most stable equimolar solution mix had.03 M of Cu, Zn, and Sn and .125 M of sodium citrate as complexing agent. The SEM mostly showed rough surfaces for all samples with electrodeposited particles with various style patterns over carbon. The EDS and XRD showed a good mass of the elements electrodeposited in a single step such as in sample C 4which contains 0.03 M Copper (II) Sulphate, 0.03 M Zinc Sulphate, 0.03 M Tin (II) sulfate, and 0.125 M Sodium citrate. As a result, it was confirmed that 0.9 mg of CZT was electrodeposited over carbon where 24.99 % zinc, 25.06 % copper, and 42.75 % tin.

Keywords: CZTS, electrodeposition, thin-film cells, photovoltaic, solar energy, alloys, corrosion resistant, brass, bronze, battery.