CHAPTER 4: CONCLUSION

Copper-lead alloys coating were electrodeposited successfully on steel substrate using electroplating technique. The electrodeposition of Cu-Pb alloys from 1 mol dm^{-3} methanesulfonic acid electrolyte with containing mixtures of 0.3 mol dm^{-3} lead (II) acetate trihydrate and 0.1 mol dm^{-3} copper (II) acetate monohydrate was studied at room temperature. Cu-Pb alloys coating were characterized for the physical and chemical properties. Effects of deposition current density on the properties of the electrodeposition were investigated. The results are summarized as follows.

The electrodeposition of Cu-Pb alloy at various current densities gave normal electrodepositon. The mass electrodepositon increased from 0.0035 g to 0.0169 g at an increased current density from range of 4 mA cm^{-2} to 18 mA cm^{-2}. The average cathodic current efficiency is 94.2% were also obtained for electrodeposition of Cu-Pb alloys. However, there was a sudden drop for current efficiency when deposited at 10 mA cm^{-2} current density is related to HER.

It is confirmed that there is a formation obtained in MSA were exhibiting fine and rough, quietly uniformity, crystalline and moderately adherence on the cathode surface.

The brightness of the electrodeposits decreased as the current density was raised from range of 4 mA cm^{-2} to 18 mA cm^{-2} without additive in the electrolyte. At high current densities above 12 mA cm^{-2}, the deposit make to be powdery were usual at high lead (II) content and yielding black coating.

The deposits were thoroughly characterised to elucidate their crystal structure, crystallite size and morphology. XRD studies revealed that the lattice structure of the deposit consist of a mixture of crystals of the two metals irrespective of current density used. The current density caused an increasing crystallinity due to massive nucleation as well controlled H_2 evolution yielding conglomerate. The crystal structure of the Cu-Pb was purely FCC. It can conclude that the crystallite size of the copper-lead alloy coating increases by increasing the deposition current density. The mean crystallite size of the Cu and Pb deposited at the deposition current density from 4 to 18 mA cm^{-2} which is estimated according to the Debye–Scherrer equation are 28.1 nm and 17.7 nm, respectively.

The result of SEM indicates that the morphology of the Cu-Pb alloys were observed on the steel surface generally detected in dendrite particles and different type of agglomerates particles of size varying from about 5 to 200 µm. These agglomerates are characterized with the presence like nodular and well defined cauliflower feature in the micron scale. The EDX results show that the existence of Pb has affected the morphology of the electrodeposit. Iron deposit was observed on the surface layer which very low content and it is confirmed thru EDX spectrum. The Pb content of the Cu-Pb alloys coating increases up to 20.7 % as the deposition current densities increases and also always below indicating normal plating with preferential deposition of Cu (the more noble metal).

In cyclic voltammetry study, it has shown that the behaviour of the metal and mixed Cu-Pb solutions with steel electrode prepared in MSA. The comparison experimental results suggested that metal ions such as Cu^{2+} and Pb^{2+} species could be incorporated into the activated glassy carbon electrode.

Finally, the deposition current density and concentration of bath were found to be the important factor in controlling the incorporation particles into the deposit.

The output of this work is interesting. Among the proposal which can be recommended for future work are:

A). The electrodeposition of Cu-Pb can be done in the presence of suitable surfactant or additive to increase the quality coating surface.

B). Future investigations will examine the electrodeposition of Cu-Pb technique in the presence of magnetic field in different environment (electrolyte composition, temperature, working electrode).

C). Future investigators should explore other aspects, for instance, AFM studies to determine the surface roughness of the electrodeposited layer.