5. CONCLUSION

5.1 Project Conclusion and overall discussion

The electrodeposition of tin in the mixture of water and air stable ionic liquid- 1-butyl-1 methyl-pyrrolidinium trifluoro-methane sulfonate and Methane Sulfonic Acid (MSA) based tin methane sulfonate salts shows the promising result in this study. The deposit was dense, fine and in polygonal grain structure.

In cyclic voltammetry and chronoamperometry studies, it has shown that the diffusion coefficient of stannous ions in BMPOTF ionic liquid is approximately 2×10^{-7} cm^2/s and was calculated from the Randles-Sevcik and Cottrell equation. Diffusion coefficient of Sn^{2+}, D has dropped when the mixture of BMPOTF and MSA tin had reached 0.5 M Sn^{2+}.

In electroplating studies, the average current efficiency are above 95% when electrodeposited with Sn^{2+} concentration in the range of 0.1 - 0.4M, and at 1 to 7 ASD. The deposit was dense, fine and in polygonal grain structure. The grain size of tin had increased from 1-2 μm to ≈5 μm proportional to current density change.

However, there was a sudden drop for current efficiency when deposited with 0.5 M MSA tin. The similar phenomenon happened in cyclic voltammetry experiments whereby the stannous diffusion coefficient dropped when the mixture of BMPOTF and MSA tin had reached 0.5 M Sn^{2+}. It was believed that the mixture of BMPOTF and MSA tin has reached saturated point at 0.5M Sn^{2+}. The ion H^+ from acid was reduced to gas hydrogen during tin deposition. The hydrogen gas was co-deposited onto the copper substrate, thus causing the tin deposit dull, porous and had poor reflectivity.

Wetting balance test, one of the methods used to test the solderability of IC leads had been carried out on the copper panels with dimension 20 mm × 20 mm that electrodeposited with 0.4 M Sn^{2+} in different electrolyte. Group 1 was the samples that plated in the mixture of Ionic Liquid (IL) -BMPOTF and MSA Tin. Group 2 was the sample that plated in the conventional Methane Sulfonic Acid (MSA) based tin plating electrolyte with the addition of commercial proprietary additive. By using the statistical t-Test diagram, there is no significant difference in term of solderability/ wetting balance time between IL plated and acidic (MSA) plated samples. It has proven that Ionic Liquid is able to achieve electroplating industrial standard or more specifically semiconductor's electroplating standard.

A main reproach is that the cost of ionic liquids is too high at the moment. Indeed, 500 gram of costs up to RM 4000. One has to bear in mind that currently one pays more or less the salary of the chemist in the laboratory who synthesizes the liquid from the educts. If a large scale production line was available, operated automatically, the costs would be reduced drastically. There is a dispute in the community about what future prices will be. One should not forget that ionic liquids electrolyte is additive-free and they can easily be recycled. Thus the overall costs for a process will decide whether an ionic liquids process will be established or not.

The dream would be that there will be – like water – one ionic liquid that is suited as a general liquid for all electrochemical reactions. It cannot be excluded that such a liquid will be produced in the future, but at present the field is in rather a developmental state. We ourselves were pretty surprised when we realized that the anion of an ionic liquid can have a dramatic effect on the electrodeposition of metals. A deeper understanding of ionic liquids will be required before ionic liquids become standard electrolytes for electroplating.