UNIVERSITI SAINS MALAYSIA

First Semester Examination
Academic Session of 2004/2005

October 2004

EBB 526 - Electronic Packaging

Time : 3 hours

Please ensure that this paper consists of EIGHT printed pages before you proceed with the examination.

This paper contains SEVEN questions.

Answer any FIVE questions. If a candidate answer more than five questions, only the first five answered will be examined and awarded marks.

Answer to any question must start on a new page.

All questions answered in English.

1. [a] An electronic cabinet made of black anodized aluminium (emmissivity = 0.96) is cooled by natural convection and radiation. The surface area of the cabinet is 0.268 m^2, the ambient is 25°C and heat transfer coefficient is 6.9 W/m^2K. Estimate the heat transfer from the cabinet if its surface temperatures is to be maintained at 125°C?

(40 marks)

[b] A 10 by 10 cm square aluminium plate is being maintained at a temperature of 100°C. Heat is removed from the other face of this plate via forced convection to an ambient temperature of 50°C. A rectangular fin with dimensions L = 5 cm, W = 10 cm, thickness = 0.5 cm is attached to the exposed face of the aluminium plate. Calculate the increase in heat transfer from the plate resulting from the presence of the fin. Assume a forced convection heat transfer of 100 W/m^2K.

(40 marks)

[c] Sketch a heat pipe and clearly label its components. Briefly describe the functions of each component.

(20 marks)

2. [a] Fill in the blanks with appropriate answers.

Materials	CUF			Purpose
			50-60	
Hardener, %				
		70-90		
Catalyst				
Toughening Agent	Additive	Additive	Additive	
Coupling Agent				
Surfactant				
Defoamer				
Colour				
Assembly Applications				

(40 marks)

[b] The Malaysian National Science Foundation (NSF) has developed a robot that can be used by its scientists for field studies in extremely cold environments in the Antartica and hot environments at the vicinity of a volcano. The robot requires a high performance microchip for data collection and sends information out to the laboratory. Under these severe environments, high performance polymers are used to package the microchip. You as the chief polymer scientist of the NSF, are required to formulate a high performance polymer to package this microchip. The success of this project is dependent on you to provide a robust polymeric material. Provide an account of the one type of encapsulating polymer that you are going to use.

(40 marks)

[c] Provide an account of either two of these materials.

(i) Mold compound

(ii) Underfill

(iii) Die attach

(20 marks)

3. (i) Draw a curve for a typical product reliability failure pattern.

(10 marks)

(ii) Name the axis correctly.

(10 marks)

(iii) What is the famous name for this curve?

(5 marks)

(iv) Split into 3 sections of failure pattern and name all three sections correctly.

(15 marks)

(v) Describe each of the 3 sections you mentioned in (iv).

(30 marks)

(vi) To predict reliability for a product at use condition, we use acceleration factor. With aid of graph, define and describe acceleration factor.

(30 marks)

4. [a] Explain why reliability of a product is so important to a company by giving three reasons.

(15 marks)

[b] What is "use condition" for a product. Give examples to elaborate.

(20 marks)

[c] List five stages of a product life cycle and elaborate them.

(25 marks)

[d] What is accelerated life testing?

(20 marks)

[e] Name 4 major conditions to consider when performing accelerated testing for a semiconductor package.

(20 marks)

5. [a] As a Materials Engineer, you need to make selection on underfill (UF) materials, list down at least 3 critical properties that need to be characterized for decision making and explain why.

(30 marks)

[b] Both DMA and TMA can be used for Tg determination:

(i) Draft the curves of TMA and DMA analysis

(20 marks)

(ii) Show how Tg can be determined by the above curve

(20 marks)

[c] Design a test profile for TGA analysis on UF and explain why such profile is chosen.

(30 marks)

6. Given the consumption rate of Ni and Cu in molten eutectic SnPb solder.

	Consumption Rate of Base metal in molten Eutectic PbSn during reflow (nm/s)	
Peak Reflow Temperature	Consumption rate of Ni	Consumption Rate of Cu
200C	0.59	2.97
220C	0.72	3.41
240C	0.89	3.81

Given :

Element	Atomic Weight	Density (g/cm^3)	Intermetallic Compound (IMC)	Density (g/cm^3)
Ni	58.70	8.9	Ni_3Sn_4	8.64
Cu	63.55	8.94	Cu_6Sn_5	8.29
Sn	118.69	7.28		

1x reflow (100 seconds at 220°C) is used to joint eutectic SnPb solder onto the two silicon chip with following base metal stack.

- Au/Cu/Ti (0.06um/1um/0.1um)
- Au/Ni/Ti (0.06um/1um/0.1um)

(a) With help of typical reflow profile and sketches, describe the reactions taken place during solder reflow. Describe type of IMC form and their morphology during and after reflow for both type of base metals.

(20 marks)

(b) Assuming Cu and Ni have negligible solubility in molten solder. Using mass conservation, derive expression relating thickness of IMC (t) to amount of base metal consumed (h) for both Cu and Ni.

(40 marks)

...7/-

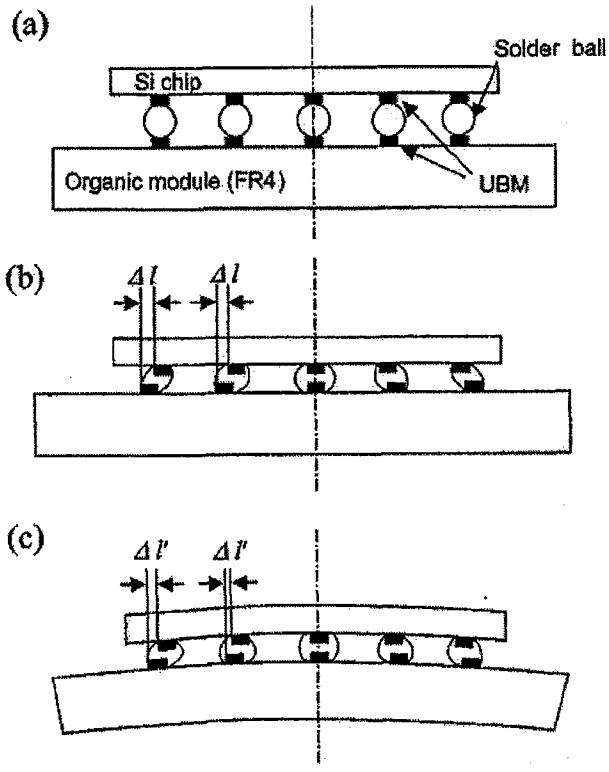
(c) Estimate amount of base metal consumed and IMC thickness after 2x reflow.

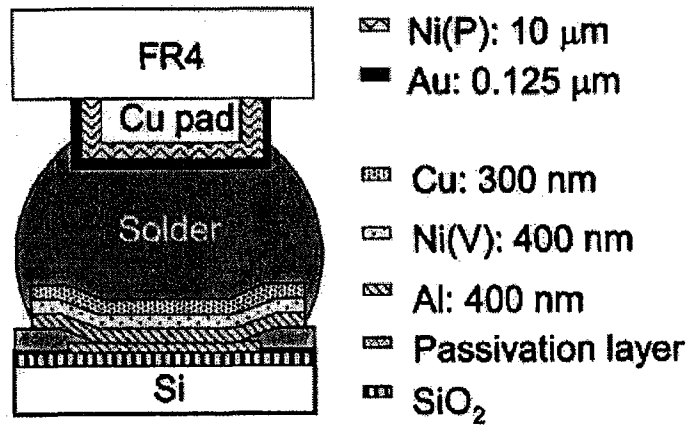
(20 marks)

(d) Given that these silicon chip need to go through 3 more times of reflow (100 seconds, 220°C). Which of the silicon chip has higher likely hood of solder joint failure? Why?

(20 marks)

7.





(d)

Coefficient of thermal expansion α for silicon = 2.6 ppm/°c

Coefficient of thermal expansion α for FR4 = 18 ppm/°c

Melting point of eutectic SnPb = 183°C

Assume room temperature = 25°C

A 1 cm x 1 cm silicon die is attached to a FR4 organic substrate with flip chip process (figure a).

- Electroless nickel immersion gold (ENIG) is used as surface finish on the FR4 substrate (figure b).
- SnPb solder is used to form the chip joint.
- Cu/NiV/Al is used as underbump metallurgy on silicon die side (figure d).

After going through eutectic PbSn solder reflow (220°C, 90 seconds above liquidus). The component is found to be concave downward as shown in figure c.

(a) Describe what origin of deformation.

(20 marks)

(b) Assuming silicon die to be very rigid, predict which solder joint will experience maximum shear. Estimate the maximum shear (Δl) as depicted in figure (b).

(30 marks)

(c) Describe type of IMC and morphology of IMC formed after reflow at both end of eutectic SnPb solder.

(20 marks)

(d) During electrical testing (after reflow) it was found that one of the solder joint at one die corner has an electrical open. Failure analysis showed that the solder joint has a brittle fracture on the substrate side. Briefly describe what caused the brittle fracture.

(30 marks)

- oooOooo -