Sensitivity Investigation of Substrate Thickness and Reflow Profile on Wafer Level Film Failures in 3D Chip Scale Packages by Finite Element Modeling

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Abstract

3D chip scale package (CSP) is one of the major trends in IC packaging with the application of wafer level films (WLF) for die-to-die or die-to-substrate attachment. However, the WLF failures (voiding/cracking) are often observed in moisture sensitivity test. Substrate thickness and reflow profile were found very sensitive to the WLF failure rate. To investigate the sensitivity of the substrate thickness and the reflow profile, a novel direct concentration approach (DCA)

visualize the whole-field vapor pressure corresponding to the instantaneous moisture distribution. With the applications of the DCA and the simplified vapor pressure model to a 3D ultra-thin stacked-die CSP, it was found that the moisture transport and escape during the reflow is the root cause of the WLF failures. A small reduction of the substrate thickness and an in-situ baking during the reflow can reduce greatly the moisture concentration and the vapor pressure at the bottom film, and therefore significantly decrease the WLF failure rate.

Introduction

3D chip scale package (CSP) is one of the major trends in l2098 of thea008 Tclngression tre it2(cr pat) different saturated concentration C_{sat} are jointed [4]. The interfacial discontinuity can be removed by normalizing the field variable. Galloway *et al.* developed an approach called partial pressure approach [4] with a new variable φ, which is defined by

$$\varphi = C / S \tag{1}$$

where φ is the partial pressure, C is the moisture concentration and S is the solubility. The solubility S is the material property and the function of the temperature.

This normalization approach is efficient to perform the moisture diffusion modeling during the soaking at the constant ambient temperature and humidity conditions, with where R is the universal gas constant, MM_{H_2O} is the molecular mass of water.

When the moisture density ρ is more than the saturated vapor

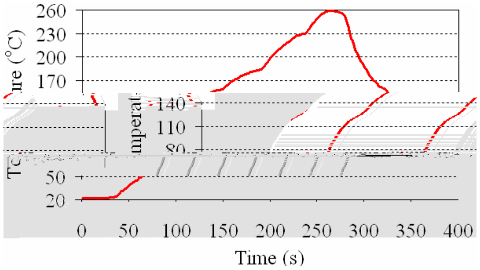

Fig. 6: Reflow profile1

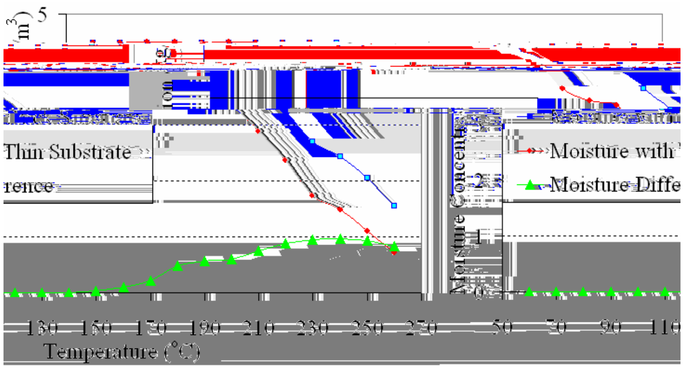

Fig. 7: Moisture comparison between the applications of the thin substrate and the thick substrate

The contours of vapor pressure at 260^{o}C when f=0.05 for

II. *Effect of Reflow Profile*

Reflow profile was also found to have significant effect on the failure rate of the bottom film in the previous study. Fig.

whole-field vapor pressure corresponding to the instantaneous