UV-curing Behaviors and Thermal Stability of Dual curable Urethane Epoxy Adhesives for Temporary Bonding in 3D Multi-Chip Package Process

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1. Introduction

Nowadays, the wafer thinning process has increased attention due to its promising application in device miniaturization and packaging. The key factors for thinned wafers are improved heat dissipation, three-dimensional stacking, reduced electrical resistance and substrate flexibility. A reduction in wafer thickness combined with an increasing wafer diameter produces the tendency for the wafer to wrap and fold and hence creates a demand for new methods of wafer handling. The thinned substrates need to be supported during the backside grinding process and through the subsequent processes such as lithography, deposition, etc. Using temporary adhesives to bond the processed device wafer to a rigid carrier wafer offers an efficient solution and is becoming increasingly important in both integrated circuit board and MEMS applications, mailnly due to its low cost, ease of processing, and adaptability [1-3].

In this study, semi-IPN structured urethane epoxy adhesives as temporary bonding adhesives in wafers were introduced using a hexafunctional acrylate monomer with a UV-curing system. Emphasis was placed on the optimal conditions such as photo-initiator contents and UV doses and so on. UV-curing behaviors were obtained by using photo-DSC, FTIR-ATR spectroscopy and gel fraction. Also, thermal stability of each sample was studied by TGA analysis.

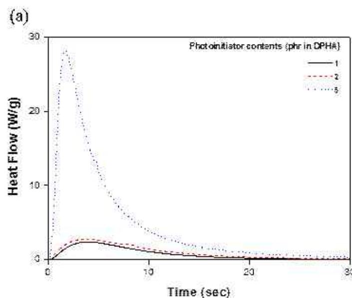
2. Experimentals

Polydimethylsiloxane (PDMS, Shin-Etsu cp., Ltd), Isophorone diisocyanate (IPDI, Bayer Material Science) were dried in 100°C, 12h prior to use and 2-hydroxyethyl methacrylate 2-HEMA, Samchun Pure Chemical Co., Ltd., Republic of Korea) was used without pretreatment. Dibutyltindilaurate is added to proceed there action to take place at a rapid rate as a catalyst i n urethane reaction. Dipentaerythritol hexacrylate (DPHA, Miwon Specialty Chemical, Republic of Korea) was used as hexafunctional diluent monomer. Hydroxydimethyl acetophenone (Micure HP-8, Miwon specialty chemical Co., Ltd, Republic of Korea) was used as the photo-initiator for the UV curing. A diglycidyl ether of bisphenol A (DGEBA) type epoxy resin (EEW: 184-190 g/eq) was supplied by Kukdo Chemical Co., Ltd, Republic of Korea). Methyltetrahydrophthalic anhydride (MeTHPA, Kukdo Chemical Co., Ltd, Republic of Korea) and triphenylphospine (TPP, Fluka, Switzerland) were used as curing agents. All samples used in the synthesis were extra pure or regent grade.

3. Results and discussion

Photo-DSC offer a simple method of characterizing the UV-curing kinetics for the photopolymerization of UV-cured materials. By monitoring the rate at which heat is released from the photopolymerized sample, the

reaction rate can be measured. Therefore, the profiles for the heat of reaction versus time provided by photo-DSC can be used to characterize the photo-induced kinetics and to evaluate the polymerization rate constants. Fig. 1 shows the isothermal UV-curing heat enthalpy and conversion profiles of UV-curable PDMS-modified urethane epoxy adhesives. The heat flow (W/g) plotted in Fig. 1 (a) can only be acquired by photo-DSC measurements and Fig. 1 (b) is the total area under the thermogram curves for samples. And the photo-DSC experiments were performed at same temperature and light intensity, 25 °C and 50mW/cm^2. At the beginning of the reaction, the early on set of auto-acceleration by activation of radicals occurred as a steep increase, which was followed by auto-deceleration as indicated in the rapid dropping curves. A difference in activity between photo-initiator contents was observed. Fig. 1 (a), there activity increased greatly with increase in concentration of radicals in the UV-curable adhesives and the peak height decreased, although their maximum conversion were all the same at about 20 sec. Because the broadening of the peak suggests that the curing has been proceeded more spread out. So a longer time was needed for it send. The total area under the thermogram curves increased with increasing photo-initiator contents, as shown in Fig. 1 (b). Minor difference was shown between 1 and 2 phr of photo-initiator contents. But a greatly increasing area was shown in 5 phr of photo-initiator contents. The dual curable adhesives showed a higher exothermic area with increase in concentration of free radicals due to the increase in the reaction energy .



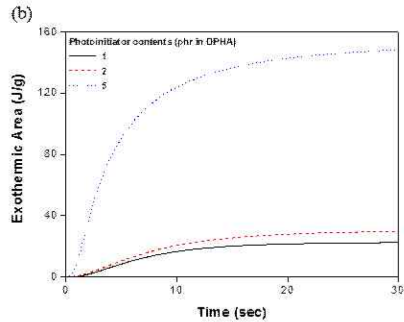


Fig. 1 (a) photo-DSC thermograms and (b) area under curve of UV-curable adhesives with different contents of the photo-initiator

4. Conclusion

An attempt has been made to obtain correlation among the data from different tests and to indicate how best the points can be established in assessing the performance of UV-curing bonding process in 3D multi-chip package process. The practical data obtained from some of the essential test based on different content of photo-initiator was discussed according to certain criteria.

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