# 電子構裝製程中複層基板熱彎曲變形之探討


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**摘 要**

電子構裝製程中，由於構裝體內部複層基板之熱膨脹係數不同，溫度變化時各層間會產生熱應力，而 造成構裝體的翹曲變形及裂縫的產生，降低電子元件的可靠度。 本論文針對電子構裝中不同材料間因溫度變化所產生之層間熱應力進行研究，分析各種不同之雙層板 及參層板層間應力解析理論，探討層間剪應力、剝離應力及正向應力等對變形的影響。比較各種不同之 複層板層間應力解析理論，經由有限元素模擬進行數值解與解析解之比較與分析，探討各理論於分析剪 應力、剝離應力及變形之準確性，以期建立一簡易可行之電子構裝複層基板層間熱應力分析系統。



關鍵詞 : 電子構裝，複層基板，熱應力，剝離應力，層間剪應力


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**參考文獻**


[ 1] HTTP://WWW.SEMILINK.COM.TW/INFO/PROCESS.HTML [ 2] LAU, J. H., BALL GRID TECHNOLOGY, MCGRAW-HILL,INC.,NEW- YORK,1995 [ 3] LOUIS, T. MANZIONE, "PLASTIC PACKAGING OF MICROELECTRONIC DEVICE" ,AT&T BELL LAB,1990 [ 4] TIMOSHENKO, S. P.,"ANALYSIS OF BI-METAL THERMO-STATS,"JOURNAL OF THE OPTICAL SOCIETY OF AMERICA, VOL. 11, PP. 233-255,1925 [ 5] ALECK, B. J.,"THERMAL STRESSES IN A RECTANGULAR PLATE CLAMPED ALONG THE EDGE,"ASME JO -URNAL OF APPLIED MECHANICS, VOL. 16, PP. 118-122,1949 [ 6] TAYLOR, T. C., AND YUAN, F. L.,"THERMAL STRESS AND FRACTURE IN SHEAR CONSTRAINED SEMI -CONDUCTOR DEVICE STRUCTURE,"IRE (INSITUTE OF RADIO ENGINEERS)TRANS. ON ELEC.DEV.,VOL .ED-9,P.303,1962 [ 7] BOGY, D. B.,"EDGE-BONDED DISSIMILAR ORTHOGONAL ELASTIC WEDGES UNDER NORMAL AND SHEAR LOADING,"ASME JOURNAL OF APPLIED MECHANICS, VOL. 35, PP. 460- 466,1968 [ 8] HESS, M. S.,"THE END PROBLEM FOR A LAMINATED ELASTIC STRIP-THE GENERAL SOLUTION,"JOUR -NAL OF COMPOSITE MATERIALS, VOL. 3,PP. 262-292,1969 [ 9] BOGY, D .B.,"ON THE PROBLEM OF EDGE-BONDED ELASTIC QUARTER PLANES LOADED AT THE BOUND -ARY,"INTERNATIONAL JOURNAL OF SOLIDS AND STRUCTURES, VOL.6, PP.1287-1313.,1970 [10] DUNDURS, J., DISCUSSION ON BOGY(1968), ASME JOURNAL OF APPLIED MECHANICS, VOL.32, PP. 650-652,1969 [11] HEIN, V. L., AND ERDOGAN, F.,"STRESS SINGULARITIES IN A TWO - MATERIAL WEDGE,"INTERNA -TIONAL JOURNAL OF FRACTURE MECHANICS, VOL. 7, PP. 317-330,1971 [12] CHEN, W. T., AND NELSON, C. W.,"THERMAL STRESS IN BOLTED JOINTS,"IBM JOURNAL OF RESEA -RCH AND DEVELOPMENT, VOL. 23, PP. 178-188,1979 [13] SUHIR, E.,"STRESSES IN BI-METAL THERMASTATS,"ASME JOURNAL OF APPLIED MECHANICS,VOL.53 ,PP. 657-660,1986 [14] RAZAQPER, A. G.., DISSCUSSION ON SUHIR'S PAPER(1986), ASME JOURNAL OF APPLIED MECHANI -CS, VOL. 54, PP. 479,1987 [15] SUHIR, E.,"AN APPROXIMATE ANALYSIS OF STRESSES IN MULTI- LAYERED ELASTIC THIN FILMS," ASME JOURNAL OF APPLIED MECHANICS, VOL. 55, PP. 143-148,1988 [16] SUHIR, E., "INTERFACIAL STRESSES IN BIMETAL THERMOSTATS,"ASME JOURNAL OF APPLIED MECH -ANICS, VOL. 56, PP. 595-599, 1989 [17] LAU, J. H., "A NOTE ON THE CALCULATION OF THERMAL STRESSES IN ELECTRONIC PACKAGING BY FINITE ELEMENT METHODS,"ASME JOURNAL OF ELECTRONIC PACKAGING,VOL. 111.PP.313-320,1989 [18] KUO, A. Y., "THERMAL STRESSES AT THE EDGE OF A BIMETALLIC THERMASTAT,"ASME JOURNAL OF APPLIED MECHANICS, VOL. 56, PP. 585-589,1989 [19] SUBRAHMANYAN, R.,

AND LI, C., 1989,"A DAMAGE INTEGRAL APPROACH TO THERMAL FATIGUE OF SOLDER JOINTS,"IEEE TRANSATIONS ON COMPONENTS, HYBRIDS, AND MANUFACTURING TECHNOLOGY, VOL. 12, NO, 4, PP. 480,1989 [20] 陳文華, "復合疊層板在自由端內部層間應力分析", 國科會研究報告NSC81-0401- E007-519,1990 [21] LEE, M., AND JASIUK, I.,"ASYMPTOTIC EXPANS FOR THE THERMAL STRESSES IN BONDED SEMI-IN -FINITE BIMATERIAL STRIPS,"ASME JOURNAL OF ELECTRONIC PACKAGING,VOL. 113, PP.173-177, 1991 [22] PAO, Y. H., AND EISELE, E.,"INTERFACIAL SHEAR AND PEEL STRESSES IN MULTILAYERED THIN STACKS SUBJECTED TO UNIFORM THERMAL LOADING,"ASME JOURNAL OF ELECTRONIC PACKAGING,VOL 113, PP.164-172,1991 [23] YIN, W. L., "THERMAL STRESSES AND FREE-EDGE EFFECTS IN LAMINATED BEAMS: A VARIATIONAL APPROACH USING STRESS FUNCTIONS,"ASME JOURNAL OF ELECTRONIC PACKAGING, VOL. 113, PP. 68-75,1991 [24] SUHIR, E., "APPROXIMATE EVALUTION OF THE ELASTIC THERMAL STRESSES IN A THIN FILM FABR -ICATED ON A VERY THICK CIRCULAR SUBSTRATE,"ASME JOURNAL OF ELECTONIC PACKAGING, VOL. 116, PP. 171-176,1994 [25] 黃明哲, "多晶片模組構裝系統基板層熱應力探討(I)",國科會研究報告NSC84-2215-E006-036,1995 [26] JIANG, Z. Q.,"THERMAL STRESSES IN LAYERED ELECTRONIC ASSEMBLIES"ASME JOURNAL OF ELECTR -ONIC PACKAGING, VOL. 119, PP. 127-132,1997 [27] WANG. K.,HAUNG. Y., CHANDRA. A.,AND HU.K.X.,"INTERFACIAL SHEAR STRESS, PEELING STRESS ,AND DIE CRACKING STRESS IN TRILAYER ELECTRONIC ASSEMBLIES"IEEE TRANSACTIONS ON COMPO -NENTS AND PACKAGING TECHNOLOGIES, VOL.23, NO. 2, PP. 309-319,2000 [28] MIRMAN, I. B.,"EFFECTS OF PEELING STRESSES IN BIMATERIAL ASSEMBLY,"ASME JOURNAL OF EL -ECTRONIC PACKAGING, VOL. 113,PP. 431-433,1991 [29] 巢慶成, "電子構裝多層結構非線性衝擊震動動態反應參維解析模式之研究",國科會研究報告NSC 83-0404- E007-075,1995 [30] 黃明哲, "多晶片模組構裝系統基板層熱應力探討(III)",國科會研究報告NSC86-2215-E006-011, 1997 [31] 陳文華,張忠民(1998),"塑膠封球柵陣列電子構裝之分析、量測與設計(一/參)-總計劃" 國科會研究報告NSC87-2212-E007-005。
[32] 劉德騏, 何正榮, "應用雲紋干涉法與有線元素模型分析PQFP型分子構裝之熱變形", 國科會研究報 告NSC87-2212-E194-017,1998 [33] 陳榮盛, "以反覆疊代之有限元素法分析高分子材料圓孔中熱黏彈之應力集中現象", 國科會研究報 告NSC86-2212-E006-008,1997 [34] E. MADENCI,S.SHKARAYER, B.SERGEER"THERMO MECHANICAL STRESSES FOR A TRIPLE JUNCTION OF DISSIMILOR MATERIALS:GLOBAL-LOCAL FINITE ELEMENT ANALYSIS"THEORETICAL APPLIED FRACTU -RE MECHANICS VOL.30, PP103-117 ,1998 [35] JUHACHI ODA, JIRO SAKAMOTO "APPLICATIONS OF FEM FOR MULTIPLE LAMILATED STRUCTURE IN EL -ECTRONIC PACKAGING"FINITE ELEMENTS IN ANALYSIS AND DESIGN VOL.30, PP147-162,1998 [36] CEUAL BASARAN, YING ZHAO "CLOSED FORM VS. FINITE ELEMENT ANALYSIS OF LAMINATED STACKS" -FINITE ELEMENTS IN ANALYSIS AND DESIGN VOL32, PP163-179 ,1999 [37] 劉時宏, "電子封裝之熱應力分析",國立成功大學碩士論文,1999。
[38] 王?村,電腦輔助工程分析之實務與應用,全華出版社,民90 [39] 彭治棠,"電子構裝及微機電系統之多層板結構理論分析與實驗驗證",國立清華大學碩士論文,2001