以微觀力學探討底部填充材對覆晶銲錫連接之可靠度研究

鍾培原、鄭江河

E-mail: 9612387@mail.dyu.edu.tw

摘 要

在電路板覆晶接合的構裝過程中，所使用的底部填充材是藉由毛細管作用填充在IC晶片的底部，由於晶片、基板、錫鉛連接和底部充填材料的熱膨脹係數不一樣，當遭受溫度變化時，由於變形的不一致，所以在銲錫連接上會有剪應力產生。因此底部充填材料必須能夠調整晶片、基板和錫鉛連接之間的熱膨脹係數差異而增強晶片與基板間銲錫連接的強度。 本文藉由微觀力學架構的發展，以ESHELBY等值內含物的原理和MORI-TANKAKA平均應力場的概念探討含有填充顆粒的底部充填材料之等效熱彈性係數，並藉由有限元素分析軟體ANSYS，由參數分析中探討底部充填材料不均勻的組成及填充物之體積分率對覆晶構裝銲錫連接的可靠度的影響。並藉由田口式方法做最佳化參數設計，探討影響錫球可靠度的重要參數。最後，本文還探討不同狀況的案例，當底部填充材填充不完全有缺陷，造成底部填充材與基板間有脫層現象產生，探討脫層狀況對錫球可靠度的影響。

關鍵詞 : 覆晶 ; 底部充填 ; 微觀力學 ; 可靠度

目錄

參考文獻

參考文獻 1.孔令臣, 民87“ 覆晶凸塊技術, ” 工業材料, 139期, 155-162頁, 7月. 2.江米珮, 民83.“ 構裝IC產品專題研究, ” 工業技術研究院電子工業研究所, 5月. 3.李宗銘, 民88.“ 異方性導電膠材料技術與應用, ” 工業材料, 147期, 93-98頁, 3月. 4.D. Suryanarayana, R. Hsiao, T. P. Gall, and J. M. McCreary, 1991.“ Enhancement of flip-chip fatigue life by encapsulation, ” IEEE Comp., Hybrids, Manufact. Technol., Vol.14, No.1, 218-223, March 5.V. Gektin, B. C. Avram and J. Ames, 1997.“ Coffin-Manson Fatigue Model of Underfill Flip-Chips, ” IEEE Trans. CPMT, part A, Vol.20, No.3, 317-326, Sep. 6.G. A. Rinne, P. A. Magill, W. C. Machon, J. D. Mis, R. T. Park and J. W. Baggs, 1998.“ Solder Alloy Selection for Flip Chip on Board, ” International Symposium on Advanced Packaging Materials, 118-122. 7.楊秉茂, 民87.“ 應用田口式品質工程分析覆晶中錫球於下填充處之應變現象, ” 國立成功大學工程科學研究所碩士論文. 8.J. B. Nysather, P. Lundstrom and J. Liu, 1998.“ Measurements of solder bump lifetime as a function of underfill material properties, ” IEEE Trans. CPMT, part A, 21 (4), 281. 9.K. Norris, 1969.“ Reliability of controlled collapse interconnections, ” IBM J. Res. Develop., p. 266, May. 10.W. Engelmaier, 1989.“ Surface mount attachment reliability of chip-leaded ceramic chip carriers on FR-4 circuit packaging, ” IEEE Trans. Comp., Hybrids, Manufact. Technol., vol. 12, June. 11.H. D. Solomon, 1986.“ Fatigue of 60/40 solder, ” IEEE Trans. Comp., Hybrids, Manufact. Technol., vol. 9, 423-432, Dec. 12.C. P. Wong, M. B. Vincent and S. shi, 1998.“ Fast-Flow underfill encapsulant: flow rate and coefficient of thermal expansion, ” IEEE Trans.

CPMT, part A, 21 (2), 360. 13.J. Wang, W. Ren, D. Zou and S. Liu, 1999.“ Effect of Cleaning and Non-Cleaning Situations on the Reliability of Flip-Chip Packages, ” IEEE Transactions on Components and Packaging Technology, Vol.22, No.2, 221-228, June. 14.A. Schubert, R. Dudek, B. Michel and H. Reichi, 1997.“ Materials Mechanics and Mechanical Reliability of Flip Chip Assemblies on Organic Substrates, ” International Symposium on Advanced Packaging Materials, 106-109. 15.S. Rzepka, F. Feustel, E. Meusel, M. A. Korhonen and C. Y. Li, 1998.“ The Effect of Underfill Imperfections on the Reliability of Flip Chip Modules: FEM Simulations and Experiments, ” IEEE Electronic Components and Technology Conference, 362-370. 16.Z. Qian, M. Lu, W. Ren and S. Liu, 1999.“ Fatigue Life Prediction of Flip-Chips in Terms of Nonlinear Behaviors of Solder and Underfill, ” IEEE Electronic Components and Technology Conference, 141-148. 17.J. H.L. Pang, T. I. Tan and S. K. Sitaraman, 1998.“ Thermo-Mechanical Analysis of Solder Joint Fatigue and Creep in a Flip Chip On Board Package Subjected to Temperature Cycling Loading, ” IEEE Electronic Components and Technology Conference, 878-883. 18.K. Darbha, J. H. Okura and A. Dasgupta, 1998.“ Impact of Underfill Filler Particles on Reliability of Flip-Chip Interconnects, ” IEEE Trans. CPMT, part A, Vol.21, No.2, 275-279, June. 19.鄭江河, 民81.“ 線性及非線性之中度填充短纖複合材料的機械性質研究, ” 國立台灣大學應用力學研究所博士論文. 20.J. S. Chang and C. H. Cheng, 1995.“ Effects of Aspect Ratios and Orientations on Thermoelastic Properties of Composites with Short Coated Fibers, ” Composites Science and Technology, Vol.55, No.4, 329-341. 21.C. H. Chen and C. H. Cheng, 1996.“ Secant Moduli of a Glass Bead Reinforced Silicone Rubber Specimen, ” J. of Composite Materials, Vol.30, No.1, 69-83. 22.C. H. Chen and C. H. Cheng, 1996.“ Effects Elastic Moduli of Misoriented Short-Fiber Composites,“ Int. J. Solids and Structures, Vol.33, No.17, 2519-2539. 23.C. H. Chen and C. H. Cheng, 1997.“ Micromechanics and Creep Behavior of Particle-Reinforced Silicone Rubber, ” ASME, J. of Applied Mechanics, Vol.64, No.4, 781-786. 24.張人傑, 2000.“ 覆晶接合方法介紹, ” 電子與材料, 第一期, 43-46頁. 25.W. W. Lee, L. T. Nguyen and G. S. Selvaduray, 1999.“ Solder Joint Fatigue Model: Review and applicability to chip scale packages ” Microelectronics Reliability, Vol.40, 231-244. 26.J. H. Lau, 1995.“ Flip Chip Technologies, ” New York, McGraw-Hill, Inc. 27.H. D. Solomon, 1986.“ Fatigue of 60/40 solder, ” IEEE Transact. Components, Hybrids, Manufact. Technol., vol. CHMT-9, 423-432, Doc. 28.Y. He, B. E. Moreira, A. Overson, S. H. Nakamura, C. Bider and J. F. Briscoe, 2000.“ Thermal characterization of an epoxy-based underfill material for flip chip packaging, ” Thermochimica Acta, 357-358, 1-8. 29.J. D. Eshelby, 1957.“ The Determination of the Elastic Field of an Ellipsoidal Inclusion and Related Problems, ” Proc. R. Soc., A241, 376-396. 30.T. Mori and K. Tanaka, 1973.“ Average Stress in Matrix and Average Elastic Energy of Materials with Misfitting Inclusions, ” Acta. Metall., Vol.21, 571-574. 31.ANSYS Menu,“ Structural Analysis User ’ s Guide, ” Reversion 5.5. 32.賴育良, 林啟豪, 謝忠祐, 1997.“ ANSYS 電腦輔助工程分析, ” 儒林書局. 33.S. Moaveni, 1999.“ Finite Element Analysis Theory and Application with ANSYS, ” New Jersey, Prentice-Hall, Inc. 34.S. Lin, J. Wang, D. Zou, X. He and Z. Qian, 1998.“ Resolving Displacement Field of Solder Ball in Flip-Chip Package by Both Phase Shifting Moire Interferometry and FEM Modeling, ” IEEE Electronic Components and Technology Conference, 1345-1353. 35.J. H. Lau, 1996.“ Solder Joint Reliability of Flip Chip and Plastic Ball Grid Array Assemblies Under Thermal, Mechanical, and Vibrational Conditions ” IEEE Trans. CPMT, part B, Vol.19, No.4, 728-735, Nov. 36.羅一元, 民88.“ 覆晶之接合處在循環熱應力作用下之可靠度分析, ” 國立成功大學工程科學研究所碩士論文. 37.Temperature Cycling, JESD22-A104-A. 38.M. S. Phadke, 1989.“ Quality Engineering Using Robust Design, ” New Jersey, Prentice-Hall, Inc. 39.慈復明, 民89.“ 覆晶CSP焊錫隆點之可靠度分析, ” 國立成功大學工程科學研究所碩士論文. 40.黃雯玲, 民89.“ 覆晶構裝中錫球受黏彈性充填材料影響之最佳化探討, ” 國立成功大學工程科學研究所碩士論文. 41.陳俊龍, 民89.“ PBGA錫球幾何外型對疲勞壽命之影響與探討, ” 中原大學機械工程研究所碩士論文. 42.J. H. Lau and S. -W. R. Lee, 2000.“ Fracture Mechanics Analysis of Low Cost Solder Bumped Flip Chip Assemblies With Imperfect Underfills, ” Transactions of the ASME, Vol.122, 306-310, Dec.