THE EFFECT OF DIFFERENT Sn-Ag-Cu (SAC) SOLDER FORM ON SOLDER/Cu JOINT PERFORMANCE THROUGH MICROWAVE HYBRID HEATING

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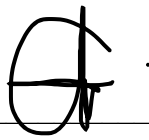

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ABSTRAK

Pateri bertindak sebagai bahan penyambung dalam pembungkusan tahap pertama seperti sambungan cip kejatuhan terkawal (C4). Ia membantu menghubungkan cip dengan substrat untuk memberikan kesinambungan elektrik dan mekanikal dalam pembungkusan elektronik. Kualiti pembungkusan elektronik kebanyakannya bergantung pada sambungan pateri yang menjadikannya perhatian utama dalam industri elektronik. Sebelum ini, proses pematerian aliran semula dilakukan untuk mematerі komponen elektronik. Oleh kerana kadar kerosakan, masa pemprosesan dan penggunaan tenaga yang tinggi, kaedah pemanasan campuran gelombang mikro (MHH) mendapat lebih perhatian di kalangan pengeluar elektronik untuk melakukan proses industri kerana bermanfaat dalam teknologi mikro moden. Kaedah MHH mempunyai kadar pemanasan yang lebih cepat, meningkatkan keseragaman pemanasan, mengurangkan kemungkinan pelarian haba, mengurangkan suhu pemprosesan, dan mengurangkan bahaya kepada manusia dan persekitaran. Kajian ini cuba menyiasat prestasi sambungan pateri dengan pelbagai bentuk pateri Sn-Ag-Cu melalui pemanasan campuran gelombang mikro. Parameter pematerian dioptimumkan dengan kaedah tindak balas permukaan (RSM) menggunakan kaedah Reka Bentuk Komposit Berpusat (CCD) untuk menyediakan parameter pematerian yang paling sesuai untuk mematerі SAC305/Cu dengan kaedah MHH dengan kekuatan ricih yang tinggi. Penyiasatan jenis pembentukan dan pertumbuhan sebatian antara logam (IMC) juga dibuat. Menurut reka bentuk eksperimen (DOE), yang dihasilkan oleh CCD, 13 sampel dipateri untuk setiap bentuk (campuran dan wayar) dan kekuatan ricihnya diuji menggunakan ujian ricih bertindan. Dari tindak balas, model matematik dibina setelah analisis varian (ANOVA) dilakukan. Model matematik dengan persamaan kuadratik dihasilkan dan ralat peratusan untuk semua sampel kurang dari 8%. Parameter yang dioptimumkan adalah jumlah kerentanan iaitu antara 3-7 g dan masa pendedahan, antara 6-10 minit. Setelah proses pengoptimuman, didapati bahawa spesimen dengan 3.05 g SiC dan 8.92 minit untuk pateri jenis wayar mempunyai kekuatan ricih tertinggi dengan 109.52 MPa, menunjukkan kenaikan 11% berbanding kekuatan ricih tertinggi sebelum pengoptimuman. Untuk pateri jenis pes, spesimen dengan kekuatan ricih tertinggi diperoleh dengan 3.03 g SiC dan 9.39 minit (109.76 MPa) menunjukkan kenaikan 2% berbanding sampel sebelum pengoptimuman. Struktur mikro IMC dianalisis menggunakan mikroskop optik dan morfologi patah ricih dianalisis menggunakan mikroskopi elektron imbasan (SEM). Hasil kajian menunjukkan bahawa ada kemungkinan tinggi untuk menggunakan kaedah MHH dalam pematerian seperti yang disahkan oleh hasil kekuatan ricih (115.45 MPa bagi pateri jenis wayar dan 109.76 MPa bagi pateri jenis pes) dan analisis IMC. IMC Cu_6Sn_5 telah dapat diperhatikan pada semua sambungan pateri/substrat dan Cu_3Sn IMC juga dijumpai pada kebanyakan sampel. Ketebalan IMC menggambarkan nilai yang boleh diterima untuk pembungkusan tahap pertama (10 um). Walaubagaimanapun, pemanasan campuran gelombang mikro menunjukkan potensi yang cerah untuk menjadi alternatif dalam teknik pematerian lain dalam industri elektronik.

ABSTRACT

Solder acts as a joining material in first level packaging such as controlled collapse chip connection (C4). It helps to interconnect chip with substrate to provide electrical and mechanical continuity in electronic packaging. The quality of electronic packaging mostly relies on the solder joint that makes it a main concern in electronic industry. Previously, reflow soldering process was performed to solder electronic component. Due to its high defect rate, processing time and energy consumption, microwave hybrid heating (MHH) method are getting more attention among electronics manufacturers to perform industrial process as it is beneficial in modern microtechnology. MHH method has faster heating rate, improve heating uniformity, reduces the chance of thermal runaway, reduce processing temperature, and subsequently, reduce hazards to human and environment. This study attempts to investigate the solder joint performance with different form of Sn-Ag-Cu solder through microwave hybrid heating. The soldering parameters were optimized by response surface method (RSM) using Central Composite Design (CCD) method to provide the most suitable soldering parameters to joint SAC305/Cu with MHH method with high shear strength. An investigation of the type of intermetallic compound (IMC) formation and growth were also made. Through this study, samples were joint via MHH and their shear strength was examined using the lap shear test, according to the design of experiment (DOE) generated by CCD. Following the analysis of variance (ANOVA), a mathematical model is built from the response. A mathematical model with quadratic equation was produced and the percentage error for all samples are less than 8%. The optimized parameters include 3-7 g of susceptor with the exposure time of 6-10 minutes. After optimization process, it was found that specimen with 3.05 g SiC and 8.92 minutes for wire solder form possess the highest shear strength with 109.52 MPa, showing increment of 11% compared to the highest shear strength before optimization. For paste solder form, specimen with highest shear strength were obtained with 3.03 g SiC and 9.39 minutes (109.76 MPa) shows increment of 2% compared to the samples before optimization. The microstructure of the IMC was analyzed using optical microscope and the morphology of the shear fracture was analyzed using scanning electron microscopy (SEM). Results showed that there was a high possibility to utilize MHH method in soldering as confirmed by the shear strength results (115.45 MPa for wire solder form and 109.76 MPa for paste solder form) and IMC analysis. Scallop-like Cu_6Sn_5 IMC were observed at all of the solder/substrate joint and Cu_3Sn IMC was found at most of the samples. The IMC thickness depicted an acceptable value for first level packaging (10 um). Hence, microwave hybrid heating shows promising ability to be an alternative in regards to the other soldering technique in electronic industry.

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