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研究报告

Sn-0.7Cu焊料在覆Cu FR-4 PCB板上电化学腐蚀及枝晶生长行为研究

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摘要: 用动电位扫描结合EDAX、XRD和SEM研究无铅焊料Sn-0.7Cu在覆Cu FR-4基板上于3.5 mass% NaCl溶液中电化学腐蚀行为及枝晶生长过程。结果显示, Sn-0.7Cu钎料腐蚀主要以共晶组织中Sn腐蚀为主; 且随着电场强度增大, 腐蚀电流密度增大, 低电场为均匀腐蚀, 高电场时有不均匀腐蚀发生。钎料枝晶生长引起“桥连”短路问题严重影响电子产品可靠性, EDAX分析表明, 枝晶上Cu离子含量大于Sn离子, 说明Cu离子的电化学迁移能力和还原沉积能力大于Sn。枝晶生长是螺旋式从内到外沿四个方向最快伸展的生长方式, 晶粒形成存在一定取向, 主要为(411)和(220); 电场强度越大, 枝晶生长速率越快, 桥连时间愈短; 当阴、阳间距为3 mm时, 两极桥连时间分别为 12.5 h (8 V), 20.4 h (5 V), 28.5 h (3 V), 39.6 h (1 V)。XRD结果显示其腐蚀产物主要为: SnO₂, SnCl₄; 枝晶组成主要为: Sn, SnO₂, SnCl₄, Cu, CuCl₂。

关键词: Sn-Cu钎料 腐蚀行为 枝晶生长 动电位扫描 SEM EDAX XRD

ELECTROCHEMICAL CORROSION BEHAVIOR AND DENDRITE GROWTH OF Sn-0.7Cu SOLDER ON FR-4 PRINTED CIRCUIT BOARD PLATED WITH Cu

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Abstract: Electrochemical corrosion characteristics and dendrites growth of lead-free Sn-0.7Cu solder on FR-4 printed circuit board plated with Cu were investigated by potentiodynamic polarization coupled with scanning electron microscope, energy dispersion X-ray analysis and X-ray diffraction analysis. The results showed that the corroded metal in solder alloy was primarily Sn, and the corrosive current density increased with electric field intensity increasing. In low electric field, uniform corrosion took place, while in high electric field, the inhomogeneous corrosion existed. "Bridge interconnection" caused by dendrite growth severely impacted on the reliability of electronic products due to short circuit. Results of EDAX analysis indicated that on dendrites the content of Cu was larger than Sn, which implied the electromigration and deoxidation capacity of Cu²⁺ were larger than those of Sn²⁺. There was crystal tropism characteristics for dendrite growth: the orientations with fastest growth rate were from four directions, the growth was spiraled from inter to outer, and the favor tropisms of crystal particles on dendrites were (411) and (220). The stronger the electric field intensity, the faster the growth of dendrites, the shorter the bridge time. The bridge time of two electrodes with 3 mm fine-pitch after dendrite growth was respectively 12.5 h for 8 V, 20.4 h for 5 V, 28.5 h for 3 V, and 39.6 h for 1 V. XRD showed that the primary corrosive products were SnO₂, SnCl₄, while the contents on dendrites were Sn, SnO₂, SnCl₄, Cu, CuCl₂.

Keywords: Sn-Cu solder corrosion behavior dendrite growth potentiodynamic polarization SEM EDAX XRD

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