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激光软钎焊反射率动态演变机理分析

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摘要：在激光软钎焊过程中，激光反射造成的元器件烧蚀问题是造成良率偏低的主要原因，但是核心物理机制并不明了。本文模拟实际工况搭建了积分球平台，得到了锡膏从熔化到液态，到最后完全铺展形成焊点过程中的激光反射率实时变化规律，发现整个过程可以分为5个阶段：低反射率阶段（23-28%）、瞬时快速升高阶段（28-60%），降低阶段（60-43%），再次升高阶段（43-64%）和稳定保持高反射率阶段（64%）。基于所用材料反射率随温度的规律、高速摄影记录的锡膏熔融铺展行为和焊点在不同时刻的截面物相形态综合分析了反射率动态变化机理，发现激光反射率与锡膏温度和熔融形状变化没有直接关系，主要取决于锡膏熔融铺展过程中的锡粉内激光多重反射吸热、锡液一次反射和由锡液到锡粉的热传导效应的共同作用。其次，最后阶段稳定保持的高反射率和月牙形锡液对激光的集中反射是造成激光软钎焊元器件灼伤的主要原因。最后，采用功率模式和温度模式混合控制出光，证明该优化工艺可抑制反射烧蚀缺陷。

关键词：激光软钎焊；反射率；铺展行为；动态变化

Abstract: The burnout of components caused by laser reflection is a major challenge for laser soldering, but the reason and mechanism have been not clear. In order to solve this problem, an integrating sphere platform was developed to observe the real-time variation of laser reflectivity (LR) from initial fusion to fully spreading out during soldering It was found that the whole process can be divided into 5 stages, which are the initial low LR stage, rapidly rising moment, decreasing stage, re-increasing stage, and stable stage with high LR (around 64%). Based on the analysis of spreading behaviors and cross microstructures of solder joints, it was found that LR is not directly related to spreading shape and temperature variation of solder paste, but depends on the interaction of laser multi-reflection within solder powders, one-time laser reflection of melt surface, and heat conduction from upper melted solder to lower unmelted powders. Accordingly, it was demonstrated that the burn damage is attributed to the combined effect of high LR and the concentrated reflection caused by crescent solder liquid at the final stage. Finally, the cooperation control methods of power mode and temperature mode was adopted to restrain the burnout.

Keywords: Laser soldering, Reflectivity, Spread out, Dynamic change

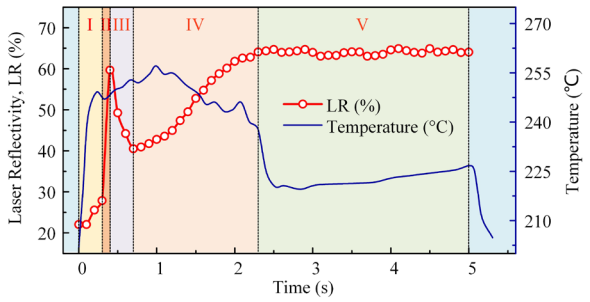

Fig. 1 Dynamic LR and corresponding temperature of laser soldering

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