摘要

本篇論文是利用有限元素法，透過電腦模擬，分別改變下列三種參數條件：通入電流、環境溫度、網格大小，藉由分析電流密度與環境溫度在不同網格密度下，隨著輸入電流增加的變化及分佈，來探討覆晶銲點之敏感度，並於不同環境溫度與網格密度條件下，找出臨界輸入電流值；並預測在高電流密度之條件下，孔洞生長的可能路徑。模擬結果顯示：Al 導線之中間點的溫度最高，電子流從 Al 導線進入 UBM 之處使 UBM 靠近陰極的邊緣有相當高的電流密度聚集，銲錫嵌入 IMC 的邊緣處也有很高的電流密度和溫度，這兩區都是關鍵易產生缺陷之處！。相同網格密度、環境溫度，輸入不同電流下，當輸入電流越大，電阻增加越多，焦耳熱的效應更劇烈，溫度上升越高！而電阻即使考慮 TCR，焦耳熱的效應中還是以電流大小為主。在高電流密度的條件下，過了潛伏期之後，孔洞最初會在銲料電流密度最大的地方成核，然後開始沿著 IMC 與銲錫的接面，對應 Al 導線前緣進入 pad 的區域擴散，接著往陽極端發展，當孔洞發展至整個截面的 99.9%時，銲錫接點產生的焦耳熱會使銲錫達到熔點，覆晶銲點也因此失效。此外，並分析材料熱傳導能力差異及熱源位置對散熱之影響。

Abstract

In this study, the finite element method is used to analyze flip chip solder joints under electromigration. Current input, environment temperature and element size are the three important factors for such electromigration simulation. We will discuss the sensitivity of flip chip solder joints under electromigration by analyzing current density distribution and temperature distribution under different current input and element size. We will also determine the critical current input for different environment temperature and element size. In addition, we investigate the void propagation in the case of high current input. It is found that the maximum temperature is within the Al trace. The location where electrons enter UBM from Al trace exist rather high current density. The solder next to the IMC also exist rather high current density and temperature. These two locations are both important and easily be damaged. For the same element size and environment temperature, resistance will increase much more when current input increases, and the effect of Joule heating will be more severe. Even though we consider temperature coefficient of resistance, current input is the major factor for the effect of Joule heating. For void nucleation and propagation issue, we use simulation to predict the path which void may propagate, and analyze the effect of Joule heating. In the case of high current input, void nucleation begins at the maximum current density region after incubation time, and then spreads along the contact area of IMC and solder. When 99.9% of the contact window is covered by the void, solder will reach its melting point and then fail by the effect of Joule heating. Furthermore, we will also analysis the influence of heat dissipation by heat conduction ability and location of heat source.