Thermal and Mechanical Problems in Microelectronics

O.F. Slattery, G. Kelly and J. Greer

Computational Modelling Group, National Microelectronics Research Centre, Lee Maltings, Prospect Row, Cork, Ireland

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Abstract: This paper aims to present a brief introduction to the topic of thermal and mechanical problems in microelectronics, specifically packaged devices. A description of typical reliability concerns at component and PCB level is given and the effects of temperature on the reliability of microelectronics devices are outlined. The origin of thermomechanically induced stresses is explained and finally, future technology requirements facing the assembly and packaging community are described and possible solutions are introduced.

1. INTRODUCTION

Management of thermal and mechanical issues in microelectronics is becoming an ever more important concern. Today, the thermal performance of electronics devices is being pushed to the limit by increasing heat fluxes, continued miniaturisation and higher speeds. An understanding of the impact of thermal issues on microelectronics reliability, as well as an ability to cater for increasing demands, is necessary for continued development.

From a thermomechanical viewpoint, electronics devices consist of a number of materials of differing mechanical properties assembled together during high temperature processes. The mismatch between the mechanical properties of the various materials coupled with high package processing
temperatures leads to the introduction of thermomechanical stresses. Excessive levels of such stresses pose a serious reliability concern.

The subject of thermal and mechanical problems in microelectronics is vast and complex and cannot be discussed in detail in a format such as this. Thus, this paper aims only to provide a brief introduction to the topic of thermal and mechanical problems in microelectronics.

2. THERMAL AND MECHANICAL FAILURES IN MICROELECTRONICS

Figure 1 shows the primary electronics failures at component level. These figures include electrical failures as well as thermal and mechanical failures since many electrical failures are activated and accelerated by temperature. This is discussed in the next section. At the package level excessive thermomechanical stresses may lead to delaminations and package and passivation layer cracks. These provide paths for moisture ingress which may lead to corrosion [1]. Wirebond failures frequently occur as a result of problems with the molding process [2] but may also be a consequence of thermal cycling.