

軸引張圧縮負荷による Sn-3.0Ag-0.5Cu の熱機械疲労寿命評価

旭吉 雅健*

Thermo-Mechanical Fatigue Life Evaluation of Sn-3.0Ag-0.5Cu under Axial Loading

Noritake HIYOSHI*

* 福井大学大学院工学研究科・機械工学専攻 (〒910-8507 福井県福井市文京 3-9-1)

*Department of Mechanical Engineering, University of Fukui (3-9-1 Bunkyo, Fukui-shi, Fukui 910-8507)

概要 はんだ接合部は、熱疲労と機械的疲労とが重畳した損傷を受ける。本研究では、はんだ用試験装置を用いて Sn-3.0Ag-0.5Cu 単体の 253 K から 353 K での熱機械疲労試験および等温低サイクル疲労試験を行い、寿命評価について検討した。熱機械疲労では、熱サイクルと機械的ひずみサイクルが逆位相の条件で引張側の平均応力を生じ、同位相の条件よりも短寿命であった。また、等温低サイクル疲労では低温度条件が高温度条件よりも短寿命となる結果であった。引張側のひずみエネルギーを考慮したパラメータを用いることによって、Sn-3.0Ag-0.5Cu の熱機械疲労および等温低サイクル疲労寿命を良好に評価可能であった。

Abstract

This study discusses the thermo-mechanical fatigue life evaluation of Sn-3.0Ag-0.5Cu lead-free solder. Since joints in electronic devices undergo not only isothermal cyclic fatigue damage but also thermo-mechanical fatigue damage due to the mismatch of the thermal expansion coefficients of different materials, it is important to clarify the thermo-mechanical fatigue properties of solders in order to accurately design products. Thermo-mechanical fatigue tests were conducted on Sn-3.0Ag-0.5Cu under both in-phase and out-of-phase conditions and a temperature range of 253 K–353 K. Isothermal low-cycle fatigue tests were also conducted. The thermo-mechanical fatigue lives under the out-of-phase condition, which has tensile mean stress, were shorter than those under the in-phase condition. The isothermal low-cycle fatigue lives at lower temperatures were shorter than those at higher temperatures. The suitability of the thermo-mechanical fatigue life evaluation parameter, which is calculated as multiplication stress and tension-side strain, is discussed in this study.

Key Words: Axial Loading, Lead-free Solders, Life Evaluation, Strain Controlled Test, Thermo-Mechanical Fatigue