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Spreading process and interfacial characteristic of Sn–17Bi–0.5Cu/Ni at temperatures ranging from 523 K to 673 K

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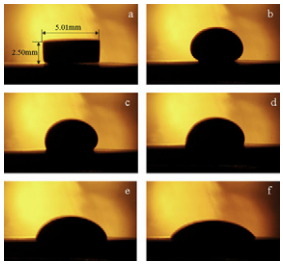
HIGHLIGHTS

- Equilibrium contact angle varies as exponential decaying equation with the temperature.
- The maximal triple line velocity approximately increases with the temperature.
- Intermetallics at the Sn–17Bi–0.5Cu/Ni interface are identified as $(Cu,Ni)_6Sn_5$ and Ni_3Sn_4.
- Linear spreading is found in the $D(t)$ curves for the Sn–17Bi–0.5Cu/Ni spreading system.
- Intermetallics enhance the triple line mobility due to their formation at the diffusion frontier.

GRAPHICAL ABSTRACT



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ABSTRACT

Spreading behaviors in the reactive Sn–Bi–Cu/Ni system were investigated by the sessile drop method at temperatures ranging from 523 K to 673 K. Contact angles and the triple line frontier, characterized by the drop base radius R, were recorded dynamically with a high resolution CCD in an Ar–H_2 flow. Equilibrium contact angles between Sn–17Bi–0.5Cu solder and Ni substrate decrease monotonously with the temperature increasing, which are 43.51°, 25.80°, 24.51° and 20.00° at 523 K, 573 K, 623 K and 673 K, respectively. Triple line mobility is obtained when calculating the derivative of R. The maximal triple line velocity approximately increases with the temperature by comparison of the four different spreading processes. Double layer intermetallics formed at the Sn–17Bi–0.5Cu/Ni interface are identified by EPMA and EDS analysis, which are $(Cu,Ni)_6Sn_5$ adjacent to the solder and Ni_3Sn_4 adjacent to the Ni substrate, respectively. The intermetallic compounds could effectively enhance the triple line mobility because of reaction product formation at the diffusion frontier.

1. Introduction

In response to the concerns over Pb, extensive investigations are going on over the last few years to find an acceptable Pb-free solder for various electronic attachment applications. A large number of Pb-free solder alloys have been proposed. The solder alloys are binary, ternary and some are even quaternary alloys, most of which are based on Sn being the primary or major constituent [1–3].

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