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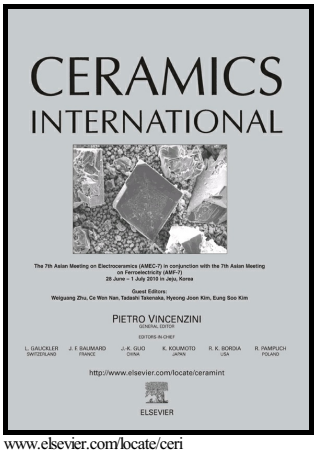

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Synthesis and characterization of ceramic nanoparticles reinforced lead-free solder

Zahra Fathian[1], Ali Maleki[2*], Behzad Niroumand[1]

[1]Department of Materials Engineering, Isfahan University of Technology, Isfahan, 84156-83111, Iran

[2]Research Institute for Steel, Isfahan University of Technology, Isfahan, 84156-83111, Iran

[*]Corresponding author: maleki110@cc.iut.ac.ir

Abstract

Sn-0.7Cu is among the least expensive types of lead-free solders available. However, its poor mechanical properties have limited its application. In this study, Sn-Cu lead-free solder reinforced with amorphous silica (SiO_2) nanoparticles was synthesized through powder metallurgy route. Desired mixtures of raw materials was mechanically milled, compressed, sintered and extruded to prepare bulk solder samples. The samples were characterized by optical and electron microscopy as well as mechanical tests. The results showed that mechanical properties were increased by addition of SiO_2 nanoparticles to the solder matrix. Addition of 1.5wt.% ceramic reinforcement to the composite increased tensile, yield and compressive strengths up to 27, 23 and 41 percent, respectively, compared to those of the monolithic sample. In addition, the ceramic nanoparticles caused an up to 50% decrease in the wetting angle between the substrate and the nanocomposite solder.

Keywords: lead-free solder, nanocomposite, Sn-Cu, SiO_2, mechanical properties, microstructure, wettability

1. Introduction

Soldering processes have been widely used in all electronic products since the beginning of the electronics era. Majority of solder materials used are traditionally based on Sn-Pb alloys. In recent decades, due to hazards of lead toxicity for humans and its environmental impacts, application of Sn-Pb solders has been prohibited. Sn-Cu [1-3], Sn-Ag [1-4] and Sn-Ag-Cu(SAC) [5, 6] have been the three pioneer lead-free solder systems [1, 7] to replace Sn-Pb. Eutectic Sn-Cu alloy, i.e. Sn-0.7Cu has good wettability, with creep and fatigue behavior better than Sn-Pb