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The effect of aging temperature on the phenomena occurring at the interface of solder SnZn with Na on Cu substrate

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ABSTRACT

The aim of this study was to show the effect of aging time, temperature and Na addition to eutectic SnZn on the kinetics of formation and growth of the Cu_5Zn_8 and $CuZn_4$ phases on Cu substrate. After a wetting test, the samples were aged at different temperatures for different times. Analysis of the microstructure of a cross section of the connection showed an $NaZn_{13}$ phase in the solder matrix, which can reduce the diffusion rate of Zn atoms to the interface.

1. Introduction

Studies exploring phenomena at the interface of solder based on eutectic SnZn and Cu substrate [1–3] are still relevant. As shown in papers [4,5], intermetallic compounds phases (IMCs) belonging to the Cu-Zn and Cu-Sn systems are created at the interface after the soldering process. The Cu_5Zn_8 layer, which impedes diffusion of Cu to the solder and inhibits the creation of precipitates of the Cu-Sn system [1], plays a very important role. Due to the fact that the system tends towards equilibrium, the phase with the lowest activation energy, which is the Cu_5Zn_8 phase [6], will be grow. In the cast SnZn+Na alloys, the addition of Na causes the creation of $NaZn_{13}$ [7]. In the soldering process, the addition of Na caused the creation of a $CuZn_4$ layer at the interface, which was an effect of binding of Zn by Na and the hindered diffusion of Zn to the interface [8]. During the annealing process, the continuity and fractures of the Cu_5Zn_8 layer are of great importance, as they determine the creation at the interface of only a layers from the Cu-Zn system, or the emergence of precipitates of the Cu-Sn system [1]. The method of preparation of samples [1], as well as the time and temperature of aging, has a significant impact on phenomena occurring at the interface of the solder and the Cu substrate [2]. Therefore, in the present study, the effect of aging time, temperature and Na addition on the size and continuity of IMCs layers at the solder/substrate interface, were studied. Retention of the integrity of the interfacial microstructure of the SnZn with Na on the Cu solder joint, the kinetics of the dissolution of Cu substrate, and the stability of the IMCs were examined.

2. Experimental

SnZn+Na cast alloys were used for obtaining a spreading measurement on Cu substrate [7]. Obtained samples after 60 s of the soldering process at a temperature of 250 °C using Alu33 flux were subjected to aging at 120 °C and 170 °C for 1, 10 and 30 days. The samples were cut into two pieces. One half was aged at 120 °C, and the second at 170 °C, in order to better reflect the effect of temperature on the phenomena occurring at interface. After aging, the samples were studied using X-ray diffraction (XRD) in order to analyse the composition of the reaction of products, and scanning electron microscopy (SEM) with energy dispersive spectroscopy (EDS), to observe the microstructure of the solder/Cu interface and analyse the composition.

3. Results and discussion

The microstructure after aging of SnZn+1.0Na (at%) alloys are presented in Fig. 1, for a temperature of 120 °C after a) 1, b) 10, and c) 30 days. The XRD analysis performed for each alloys confirm the IMCs occurring at the interface from the Cu-Sn and Cu-Zn systems. During aging at 120 °C, IMCs layers grow at the interface over time. The microstructure after aging for 1 day, presented in Fig. 1a, shows two layers of phases, dark $CuZn_4$ (very thin) and grey Cu_5Zn_8, which were formed at the interface the same as on the samples after the wetting test, and which was confirmed XRD analysis. After 10 days, the $CuZn_4$ ceases to be continuous and the small precipitates of $CuZn_4$ dissolve in solder (Fig. 1b). Even after 30 days, the Cu_5Zn_8 layer still continues to grow over time, as shown in Fig. 1c.

Such growth of the Cu_5Zn_8 layer is possible when the layer is

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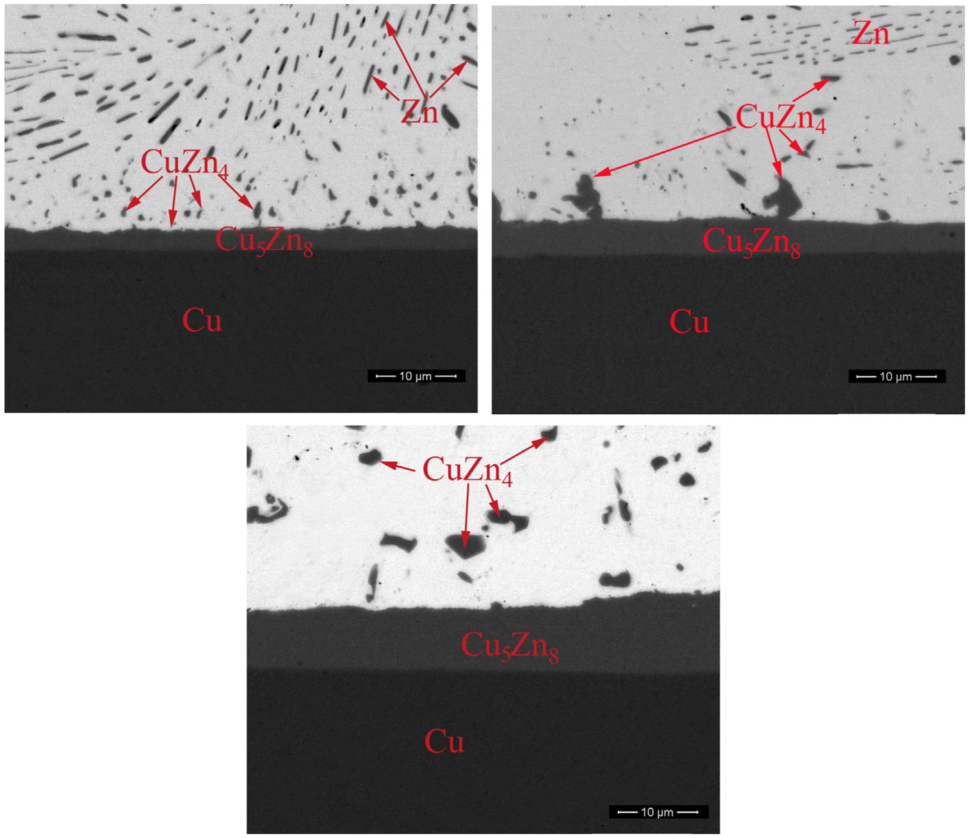

Fig. 1. The microstructure after aging of SnZn+1.0Na (at%) alloys for a temperature of 120 °C after (a) 1, (b) 10, and (c) 30 days.

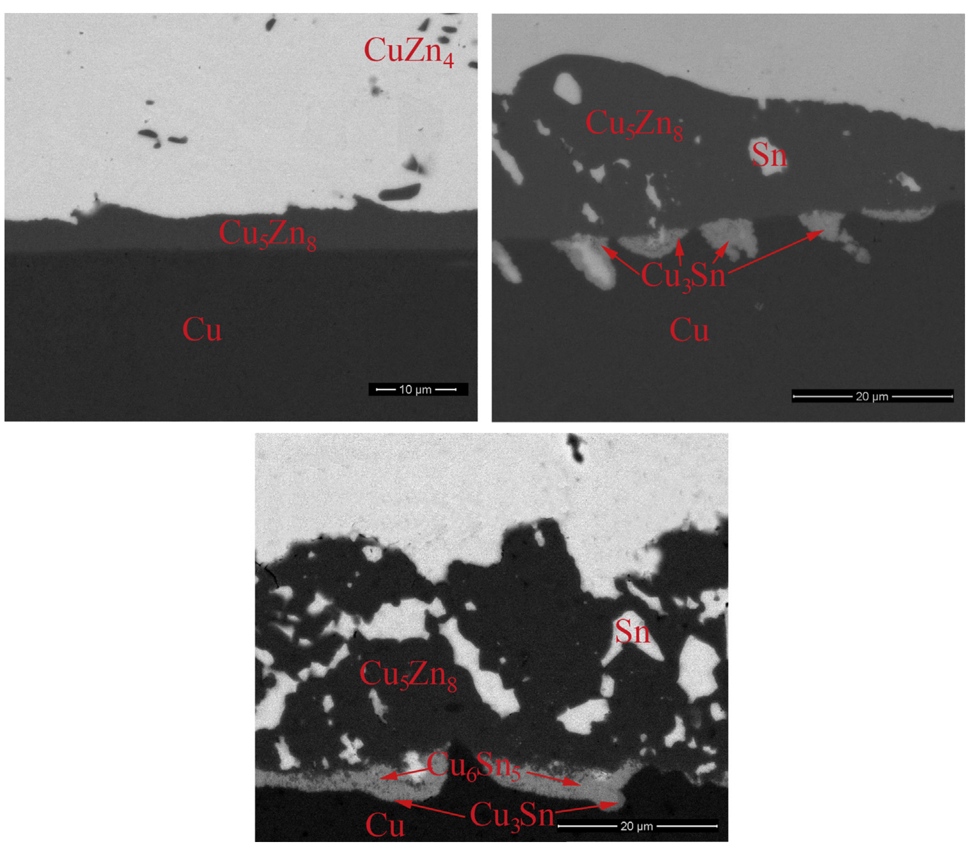

Fig. 2. The microstructure after aging of SnZn+1.0Na (at%) alloys for a temperature of 170 °C after (a) 1, (b) 10, and (c) 30 days.