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Phase transformations in diffusion-reaction Cu/In couples

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The crystal structure for the intermetallic Cu_2In (η'/η) phases of the Cu-In system in the composition rage 33-38 at. %In are not yet clearly established (Fig. 1). Diffusion-reaction Cu/In couples are studied between 300 and 600ºC at different annealing times. The aim of this work is to determine the temperature and the composition stability ranges for the Cu_2In phases in the Cu-In phase diagram. The couples are characterized by XRD, SEM-WDS and optical microscopy in order to obtain information about chemical composition, crystal structure and kinetic behavior. Two different morphologies can be seen according to the reaction fronts (Fig.2).

The binary Cu-In system presents some complexity and shows contradictions in the literature, especially in the 33-38%at In. In 1989 Subramanian *et al.* [1] proponed a phase diagram with some imprecision in the 32-100% In. Based on that study Jain *et al.* [2] suggested the existence of 5 phases h, A, A', B and C for the range of 31 to 45% In. Later Bolcavage et al. in 1993 [3] investigated the 33-60%In region and they report the presence of only 2 phases η/η'. In 1997 Elding-Pontén *et al*. [4] confirm by electron diffraction the presence of B and C phases proposed early by Jain *et al.* [2], while the h, A and A' are attribute to only one phase, named A. Recently Bahari et al. [5] in 2003 using DSC found only two phases η/η', confirming a transition temperature of 388.3 °C for the reaction $\eta' + \delta \rightarrow \eta$, which was proposed by Bolcavage et al. [3] at 389° C. For In-rich regions Bahari et al. [5] found an endothermic peak at 276.6 °C corresponding to the reaction $\eta' \rightarrow \eta + Cu_{11}In_9$ with is indicated in the phase diagram with dotted lines [3]. The crystal structure proposed for the high temperature phase η' is the $B8_1$ hp4 $P6_3/mmc$ and the prototype is the NiAs. There is uncertainty about the structure of the low temperatures phase η. This could display one or more alternative structures based on the type hp6 ($B8_2$: $InNi_2$)/hp4 or orthorhombic. Those and the other phases associated for this system are of special interest since In and Sn are used in Pb-free solders to bong Ag, Al, Au, Cu, Ni substrates forming complex multicomponent systems [6-8].
The growth of the intermetallic phases in the couples follows a parabolic behavior in the whole temperature range. A delay was found in the formation of the second intermetallic phases after the complete consumption of the In liquid phase. The XRD analysis showed the changes in the crystal structure parameters with the annealing times and temperatures in the couples.

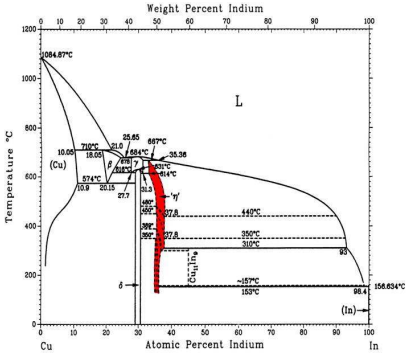

Figure 1. Equilibrium Phase Diagram Cu-In [3]

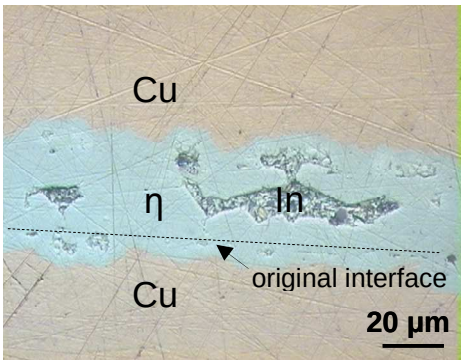

Figure 2. SEM micrograph of a Cu/In couple annealed at 350ºC during 10 min.

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