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Topics in Lead-Free Solders: Interfacial and Sn Whisker Growth

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The legislated ban on lead in electrical and electronic equipment was implemented throughout the European Union through Restriction of the use of certain Hazardous Substances in Electrical and Electronic Equipment (RoHS) directives,[1] while "Management Methods for Prevention and Control of Pollution from Production of Electronic and Information Products"[2] was drafted by China. In the United States, California[3] legislated electronic waste recycling but not a total ban on lead in electronics. These laws have motivated electronic products manufacturers to implement lead-free solders and to market "green" products. However, after working several decades with Sn-Pb solder alloys, the so-called "drop-in replacement" lead-free solder alloys still has several question marks even in the fundamental understanding of the interactions involving solders and lead-free finishes. Thus, the Electronic Packaging and Interconnection Materials Committee of the TMS Electronic, Magnetic & Photonic Materials Division has conducted a series of successful symposia on lead-free and lead-bearing solders over the past few years. The symposia have been held at TMS annual and fall meetings, and the results have been published[4–17] in *JOM* and special issues of the Journal of Electronic Materials (*JEM*). Continuing the trend, the recent Pb-Free Solders and Other Materials for Emerging Interconnect and Packaging Technologies symposium held March 11–15, 2012, at the TMS 2012 Annual Meeting in Orlando, Florida, attracted a large number of participants. At the symposium organized by Iver Anderson et al., more than 75 papers dealing with next-generation packaging, whisker growth, alloy and microstructural development, thermo-mechanical behavior, electromigration, processing, and reliability for lead-free solders were presented. The two articles selected for this issue of *JOM* deal with Sn whisker growth and interfacial growth in lead-free solders.

Sn finish is an economical way of replacing Sn-Pb solders on lead frames, but plated pure Sn can nucleate and grow whiskers that are detrimental to the reliability of the devices and printed circuit board assembly (PCBA). In the first article, F. Pei et al. present *in situ* scanning electron microscopy/elecron backscatter diffraction (SEM/EBSD) to monitor simultaneously the evolution of surface morphology and grain orientation in Sn surfaces to correlate whisker/hillock initiation with the underlying microstructure.

The second article by K.L. Lin is a review of the interphases (phases at the interfacial region) formed during the very early stage of the soldering process for various solder systems. A close investigation of the interphases formed at the very early stage of soldering will root out understanding of the soldering process. Although no *in situ* observation at the liquid/solid interaction was possible thus far, a number of studies adopted rapid quench of the soldered specimen at the very early stage of interaction to freeze the occurrence.

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