JOM, Vol. 65, No. 10, 2013
DOI: 10.1007/s11837-013-0715-z

Topics in Lead-Free Solders: Restriction of Hazardous Substances Recast (RoHS2)

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The legislated ban on Pb, Cd, Hg, Cr-VI, polybrominated biphenyl (PBB), and polybrominated diphenyl ether (PBDE) in electrical and electronic equipment was implemented throughout the European Union (EU) by Restriction of Hazardous Substances (RoHS) directives[1] in Electrical and Electronic Equipment (EEE), 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. However, the EU repealed the initial directive on 2 January 2013 and replaced it with Directive 2011/65/EU/00. This new RoHS2[4] focuses on controlling EEE waste by simplifying and harmonizing with EU legislation so as to make it easily enforceable while increasing the legal clarity. Also, medical devices, monitoring and controlling instruments, and several sundry areas are no longer exempt. Significantly, Conformité Européenne marking and declaration of conformity are mandatory as of 3 January 2013, and the use of prior "green" and "no-lead" labels was totally scrapped. In accordance with the aforementioned legislations, the Electronic Packaging and Interconnection Materials (EPIM) Committee of the TMS Electronic, Magnetic & Photonic Materials (EMPMD) Division organized a series of successful symposia on lead-free and lead-bearing solders in the past few years. The symposia were held at TMS annual and fall meetings, and the results were published[5–18] in *JOM* and special issues of the *Journal of Electronic Materials* (*JEM*). Continuing the trend, the recent "Pb-free Solders and Emerging Interconnect and Packaging Technologies" symposium held 3–7 March 2013 at the TMS Annual Meeting in San Antonio, TX attracted a large number of participants. At the symposium organized by Nikhilesh Chawla et al., more than 49 papers and 22 posters dealing with next generation packaging, whisker growth, alloy and microstructural development, thermomechanical behavior, electromigration, processing, and reliability for lead-free solders were presented. The two papers selected for this issue of *JOM* deal with Sn whisker growth, and solder joint reliability in lead-free solders.

Pure Sn finish is an economical way of replacing Sn-Pb solders on lead-frames, but plated pure Sn can nucleate and grow whiskers and hillocks that are detrimental to the reliability of the devices and printed circuit board assembly. In the first paper, "A Predictive Model for Whisker Formation Based on Local Microstructure and Grain Boundary Properties," P. Sarobol et al. discuss local microstructural characteristics along with predictive models that promote whisker growth.

The second paper, "Characterization of Solder Joint Reliability Using Cyclic Mechanical Fatigue Testing," by C. Kim et al. is a review of cyclic bend fatigue and shear fatigue mechanisms that induce solder failure in electronics packages. The authors used numerical simulations applied to Sn-Pb and Pb-free solders to show the effect of most important factors such as chip geometry, solder mask, etc. on the failure mode.

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(Published online August 21, 2013)

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