Editorial

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Lead toxicity, as it affects the environment and health, has produced a significant increase during the past 10 years in the number of extensive studies concerned with developing a replacement lead-free solder to substitute for the traditional tin-lead (Sn-Pb) solders that have been used since Roman times. Two kinds of alloys, which are currently being considered for substitute materials, are based on Sn-Ag or Sn-Ag-Cu near-eutectic compositions and more recently on Sn-Zn eutectic. Both groups of alloys are limited in their industrial application due to their melting temperature, wettability, mechanical properties, and cost.

In keeping with (a) the Polish tradition of involvement with quantitative science, which began with the observations of Copernicus in Krakow dealing with planetary orbits and laid to rest Aristotelian belief in the immutability of the heavens to initiate the present Age of Science and (b) the near-simultaneous development of the calculus by Liebniz in Poland and Newton in Britain, which gave us the tool for quantitative science, the Institute of Metallurgy and Materials Science, Polish Academy of Sciences in Krakow in 1998 initiated studies on Pb-free alloys. These works initially concentrated on wettability, but later extended to diffusion soldering and to measurement of thermodynamic properties, which were then used to calculate phase diagrams for proposed substitute materials. These studies have been conducted within a framework of both international and domestic cooperation, including joint projects with Tohoku University and with domestic industrial institutes (both initiated in 2000), within the European COST 531 Program (2002-2006), and within the international ELFNET (European Lead Free soldering NETwork) (2004-2006), which comprises 19 countries that are members of the European Community.

Wettability studies involving Bi, Sb, and In additions to both eutectic Sn-Ag and Sn-Ag-Cu alloys to obtain properties closer to traditional Sn-Pb solders found that there were limitations on the useful amounts of the additions. Furthermore, through a combination of the results from surface tension and density measurements with meniscographic studies starting from Sn-Ag and progressing through Sn-Ag-Cu-Bi-Sb, the metric of wettability in terms of the change of surface tension and contact angle or interfacial tension and contact angle was confirmed. Because pure indium has about the same density and surface tension as tin, extending these studies to indium additions to the base alloys of Sn-Ag, Sn-Ag-Cu, or Sn-Zn limits the metric of wettability solely to the change of the contact angle. The composite data from these extensive studies of surface tension, density, and modeling were the basis for generating the SURDAT database (available on website http://www.imim.pl/index.php?id=215).

During the most recent meeting of the ELFNET at the beginning of 2007 in San Sebastian, Spain, it became clear that the present lead-free solders are suitable for only 50% of the soldering applications in the automotive, space, and oil industries. Hence, a composite approach was proposed to solve this problem. The basic purpose of this approach is to achieve a refined microstructure and to improve the mechanical properties by an addition of secondary particles to a solder matrix so as to form a composite. However, the incorporation of such secondary particles within a solder matrix is difficult to achieve as has been indicated by several recent reports. Thus further research on lead-free solders remains to be done, and the Institute of Metallurgy and Materials Science at Krakow intends to do its part.

In connection with the Institute, it may be noted that in 2006 two prominent emeritus professors—Dr. J.F. Smith from Iowa State University and Dr. B. Predel, the former director of the Max Planck Institute in Stuttgart, Germany, and now deceased—were elected as Foreign Members of the Polish Academy of Arts and Sciences. This was in recognition of the scientific achievements of both professors and for their contribution to the development of cooperation with the Institute of Metallurgy and Materials Science at Krakow. The Polish Academy of Arts and Sciences (PAU) was founded in 1872 and was a transformation outgrowth of the Krakow Learned Society, which itself was founded in 1815. As of January 2004, the PAU had 441 members, including 151 foreign members, each of whom maintains active contacts with Polish science and learning. A particularly noteworthy honarary member of PAU was elected June 15, 1999; he was widely known as Pope John Paul II.

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