EFSOT

IMS Project No. 01011

Next Generation Environment-Friendly Soldering Technology

Final Report

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1. Overview

EFSOT is the acronym for the IMS project “Next Generation Environment-Friendly Soldering Technology”. It was proposed with a view to develop a number of joining materials and processes capable of minimizing the overall harmful effect arising from such materials and processes, and thus to help reduce their adverse impact on the environment.

The project was developed focused on such issues as natural environment, resource depletion, energy consumption, recylability and reusability. It had some very unique approaches from environmental and biological and resource circulation standpoints.

The overall objective of EFSOT was to develop a next-generation soldering technology, and to disseminate the information emanating from the project. The “General work plan” is shown in the figure below.

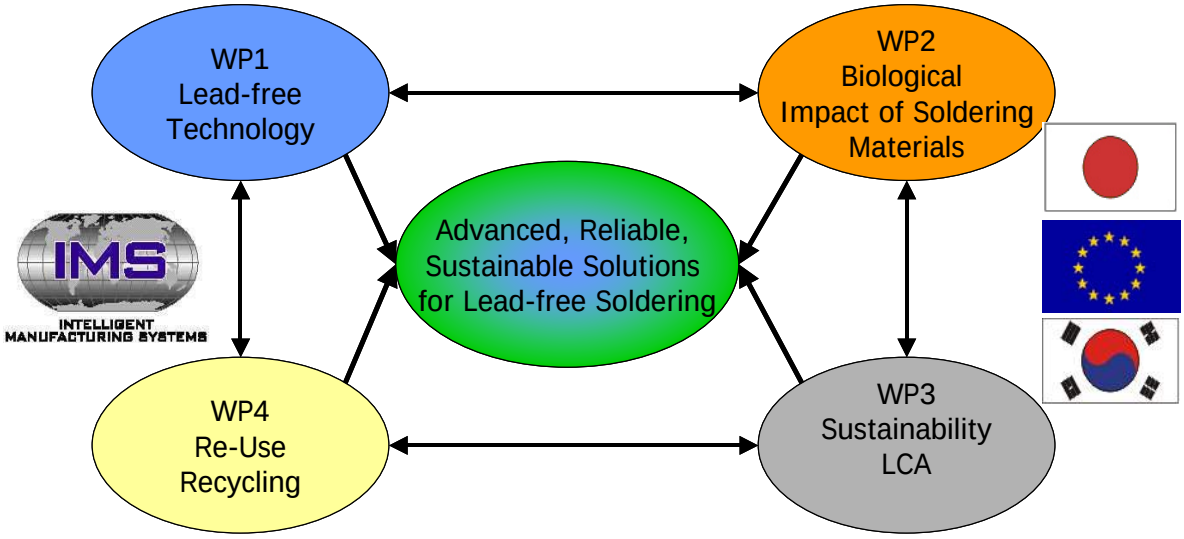

Figure General work plan

EFSOT comprised 4 technical work packages. WP1 focuses on the upgrading of lead-free soldering technology and on new joining material and process technologies. WP2 focuses on the evaluation of biological impact of lead-free solder. WP3 on the evaluation of environmental impact and WP4 on recycling

and reuse technologies. The project was undertaken with an aim at fining Advanced, Reliable, Sustainable Solutions for Lead-free Soldering.

The project was carried out by an international consortium involving three IMS regions; Japan, EU and Korea. Japan, EU and Korea has 14, 8 and 4 partners respectively, so the total is 26 partners. In all 26 partners, 13 that is half are industrial entities, 9 are educational institutions and 4 are research organizations. The partners were as listed below:

Japan:

- Hitachi, Ltd. (ICP, RCP)
- Fujitsu Limited
- NEC Corporation (2004-2005)
- OKI Electric Industry Co., Ltd.
- National Institute of Advanced Industrial Science and Technology, Research Center for Life Cycle Assessment
- Hokkaido Industrial Research Institute
- Hokkaido University
- Juntendo University
- National Institute for Environmental Studies
- Osaka University, Department of Manufacturing Science
- Osaka University, Collaborative Research Center for Advanced Science and Technology
- Shizuoka University
- Tohoku University
- The University of Tokyo

European Union:

- Technical University Berlin (RCP)
- Philips Electronics Netherlands B.V.
- Pre Consultants B.V.
- THOMSON multimedia
- Avantec
- AB Microelectronics
- Gaiker
- Indumetal Recycling

Korea:

- LG Electronics (RCP)
- Korea Institute of Industrial Technology
- Jeaneung College
- ECOJOIN

The project was undertaken over a period of three years starting from February 2003 and ending in September 2005. At the final meeting in Yokohama on September 26 and 27, the partners presented their final results.

2. Findings

The researchers confirmed that waste electric and electronic equipment with wiring board printed with a lead-free solder is actually less toxic for humans. However, there is also a significant price to pay for this benefit. The soldering process using most lead-free solders results in a larger energy consumption because of their higher melting points. Another price to pay is that the lead-free solders contain metals harder to come by than lead, implying a larger amount energy is consumed and a larger volume of undesirable gases is emitted during their mining and smelting processes.

In accordance to these and other findings some of the lead free solders were rated as shown in Table below:

Table. Rating of lead-free solders

Types of solder	Jointability	Toxicity	Resource depletion	Total impact assessment	Remarks
Sn-Sb, Sn-Ag-Cu-Sb					- Sb toxicity higher than Pb - Refrain from use of Sb solder
Sn-Ag-Cu, Sn-Cu					- Best solution in the present state - Necessity to construct recycling system of Ag and Sn in the future
Sn-Ag-In-Cu(Bi)					- In severe resource depletion - Transitional use for low heat resistant components
Sn-Zn(-Bi)					- Practical use for some products - Impossible to use for wave in current - Possibility of the usage expansion by improvement of jointablility - Necessity to construct recycling system of Sn in the future

very good good average bad

The findings from the project are summarised in the Chart shown below.

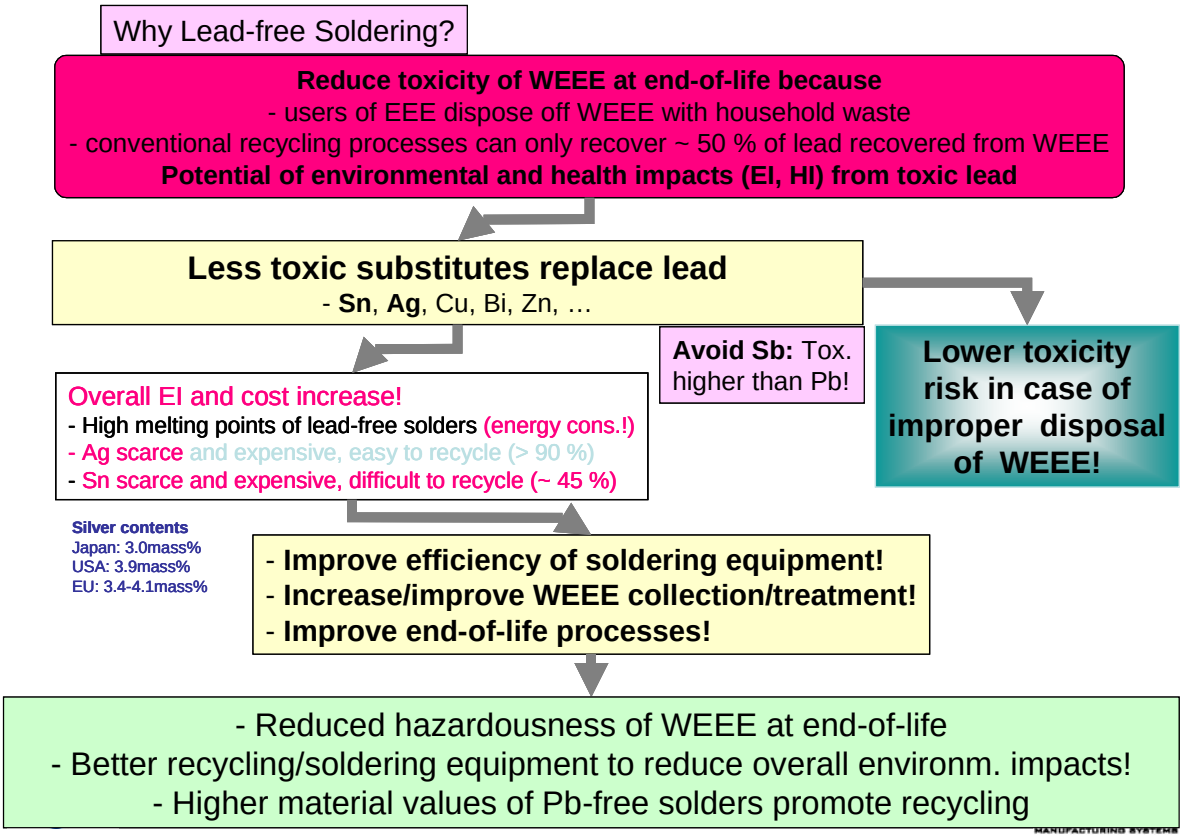

Chart. Summary of the findings from EFSOT

3. Recommendations

Upon completion of this international consortium, the researchers involved recommend the following:

The electronics industry should use tin-silver-copper type solders with a maximum of 3 % of silver for reflow and wave soldering. For wave soldering, tin-copper type solders are recommended. Industry should focus their research on the application of solders with low-melting point, e. g. tin-zinc, tin-zinc-bismuth types, as prospective lead-free solders. These solders would reduce the energy consumption as well as thermal stress brought about in electronic components during soldering process. Solders with antimony, e. g. tin-antimony, tin-silver type solders containing indium should be avoided. Antimony proved to be more toxic than lead, and the general use of indium would result in resource problems, as its stocks are small and its recycling entails difficulties.

Electronics manufacturers should consider whether new soldering ovens can increase the energy efficiency, and oven manufacturers must improve the efficiency of this equipment.

The use of such scarce metals as silver and tin requires stimulating the collection and recycling of waste of electric and electronic equipment. Especially the nowadays low recycling rates of tin call for more effective technologies to recycle solders from used printed-wiring-boards. Effort is required of competent governmental organs to promote Green Mining initiatives as mining of metals used for lead-free solders is a major source of environmental deterioration in the entire life cycle of lead-free solders.

It is hoped that the findings from EFSOT project undertaken by using integrated approaches and methodologies to develop environmentally friendly solders and soldering technologies will serve as a solid platform for industry to further develop innovative soldering materials and processes.

The researchers who participated in this project hope that these findings may be of help for legislators all over the world in reviewing the current rules and regulations regarding environmental conservation in general and soldering materials and processes in particular.