

Development of Futuristic Tin-based Materials As New Generation Electronic Solders

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Motivation: Electronic industry is currently using Sn-Pb solders which are not environment and health friendly. Accordingly they are designated to be phased out by January 2007 in accordance with the guidelines issued by Japan and European Union. In view of this, there will be a strong requirement in the immediate future to replace them with eco-friendly lead free solders. **The development of tin based materials using composite technology is the prime motivation of this proposal.**

Objective & Scope of Project: To develop new generation of high performance tin-based materials employing composite technology for applications in electronic industry. Additionally, this project also targets the use and development of energy efficient processing technique such as **microwave heating** for the fabrication of tin-based materials in place of conventional processing techniques.

Industrial Significance: This project will help to cater to the increasing demand in lead free electronic solder as a result of international legislation banning the use of conventional tin-lead solder and increasing environmental concern over the toxicity of lead. **Energy savings of more than 90%** can be achieved with the use of microwave heating when compared to conventional heating. This is in line with one of the strategies stipulated by the International Energy Agency for improving energy efficiency to meet the increasing demand in energy globally.

Target Industries: Electronic industry comprising of users and manufacturers of lead free solders.



Source: NEC <http://www.nec.co.jp/eco/en/annual2005/04/4-2-17.html>

Table 1 World Tin Consumption from 2001 to 2007.

World Consumption Of Refined Tin							
(¹ 000 tonnes)	2001	2002	2003	2004	2005	Estimate 2006	Forecast 2007
China	62.1	53.2	71.7	89.8	103.2	123.0	130.0
Japan	21.5	26.8	28.8	33.1	33.2	37.0	37.0
Other Asia	49.9	55.6	58.1	60.9	65.8	67.0	70.0
USA	47.8	49.2	44.7	53.9	42.1	46.0	48.0
Other Americas	15.5	16.2	16.7	17.6	16.8	17.0	19.0
Europe	74.8	67.8	70.3	68.2	66.0	72.0	75.0
Other	6.2	7.0	6.2	4.5	4.8	5.0	5.5
Total World	277.9	275.8	296.6	328.0	331.9	367.0	384.5

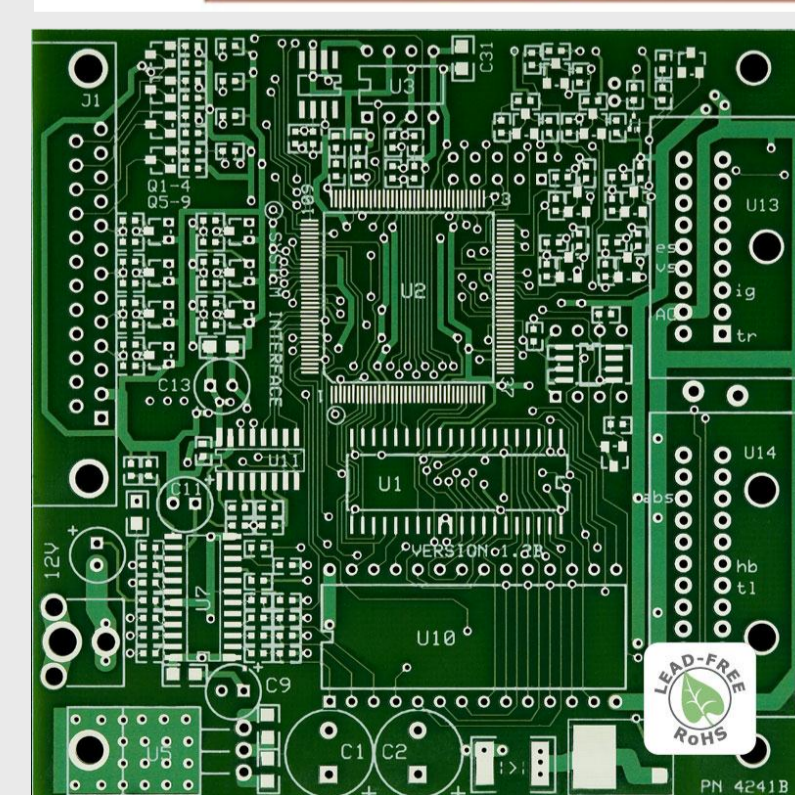
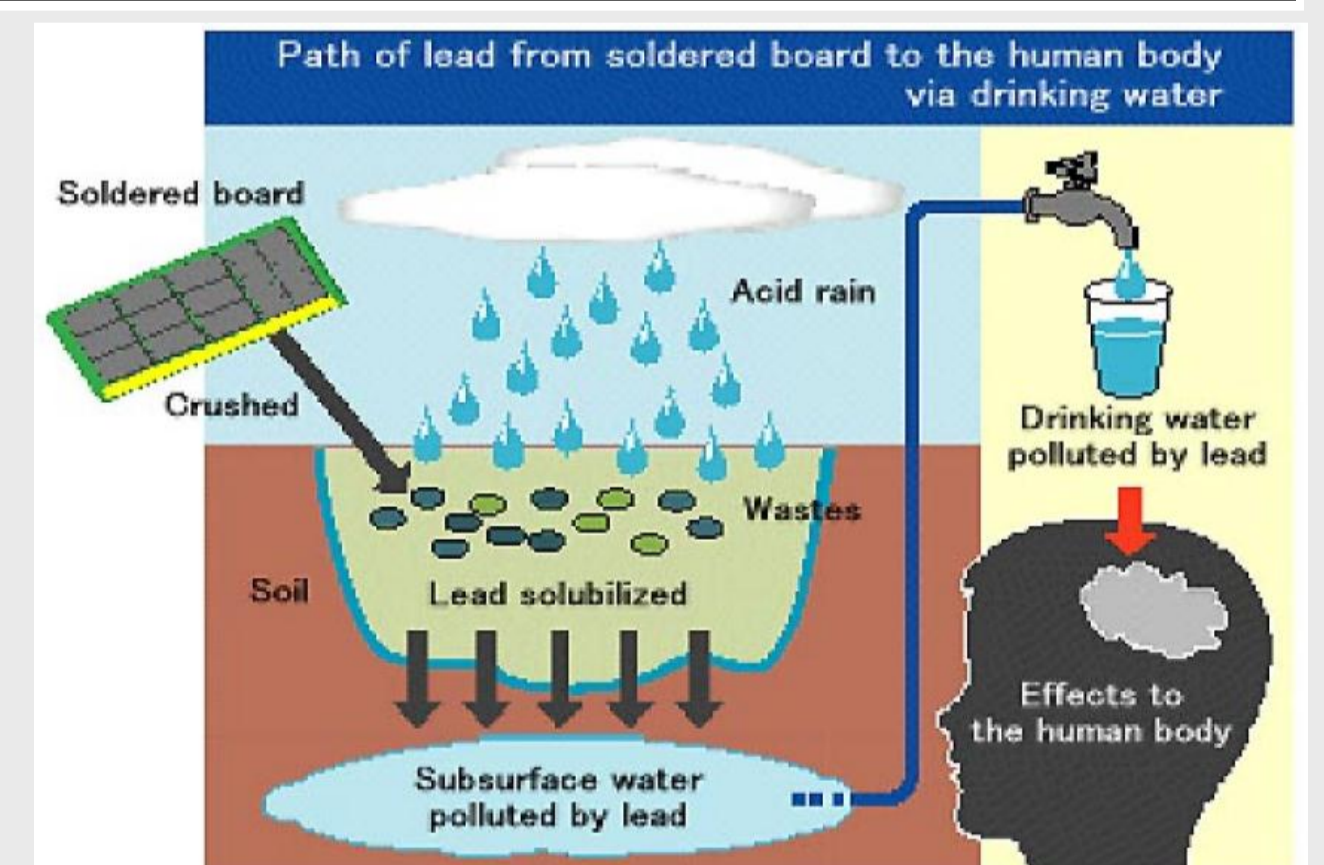
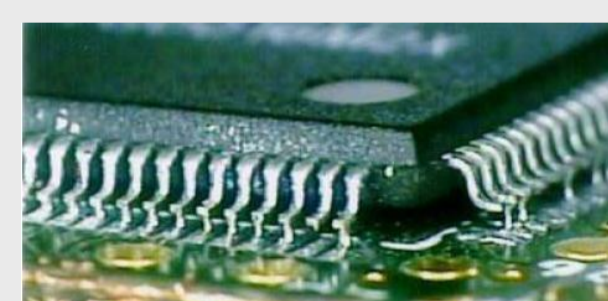
Data: CRU, WBMS

Source: Tin Technology Ltd

Preliminary Studies

Table 2 Results of Tensile Properties of Tin-based Alloys.

Material	0.2%YS (MPa)	UTS (MPa)	Ductility (%)
Viromet (Microwave) [1]	50 ± 3	56 ± 5	51 ± 2
Viromet (Manufacturer Specification) [1]	50.9	65.1	34.3
Viromet (Conventional) [2]	56 ± 6	60 ± 8	37 ± 7
Viromet/1%Al ₂ O ₃ [2]	72 ± 6	75 ± 6	21 ± 3
Viromet/3%Al ₂ O ₃ [2]	73 ± 3	77 ± 3	11 ± 3
Viromet/5%Al ₂ O ₃ [2]	74 ± 3	76 ± 2	10 ± 0
SAC [4]	31 ± 2	35 ± 1	41 ± 8
SAC – 0.01CNT [3]	36 ± 2	47 ± 1	36 ± 2
SAC – 0.04CNT [3]	36 ± 4	46 ± 6	37 ± 5
SAC – 0.07CNT [3]	33 ± 3	43 ± 5	35 ± 4
SAC – 1.5TiB ₂ [4]	32 ± 1	38 ± 1	30 ± 2
SAC – 3TiB ₂ [4]	39 ± 4	43 ± 5	29 ± 2
SAC – 5TiB ₂ [4]	34 ± 4	38 ± 2	24 ± 7



Source: ExpressPCB



Source: Winland Electronics Inc.



Source: High Power Inc.

1. M. Gupta and W.L.E. Wong, "Enhancing Overall Mechanical Performance of Metallic Materials using Two-directional Microwave Assisted Rapid Sintering", *Scripta Mater.*, 52, 479-483, 2005.
 2. S.M.L. Nai, J. Wei and M. Gupta, Improving the performance of lead-free solder reinforced with multi-walled carbon nanotubes, *Materials Science and Engineering A*, 423, 166-169, 2006.
 3. S.M.L. Nai, J. Wei and M. Gupta, Influence of ceramic reinforcements on the wettability and mechanical properties of novel lead-free solder composites, *Thin Solid Films*, 504, 401-404, 2006.
 4. X.L. Zhong and M. Gupta, High Strength Lead-Free Composite Solder Materials Using Nano Al₂O₃ as Reinforcement, *Advanced Engineering Materials*, 7, 1049-1054, 2005.

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