Lead free / Green Packaging

Semiconductor and Electronics Industry have recognized the inherent dangers and the environmental concerns that arise out of using Lead and their compounds in their manufacturing operations, such as solder plating. The awareness over the consequence in using Lead forced the Semiconductor and Electronics industry to find an alternative that is environmental friendly. The lead free initiative is driven on a global basis and it is felt worldwide with OEMs marketing environmentally friendly products. As the world rises to adapt to the environmental concerns it is mandatory for all Semiconductor assembly and test service providers to have this option readily available to comply with the legislation and also to be in pace with the revolutionary industry demands.

Influence of Lead on Human body

Electronic components are connected to the electronic circuit boards and these boards are densly packed with components to increase the functionality and to make them smaller and cheaper. Though there are ways for recycling these circuit boards most of them are crushed and buried as “special industrial waste”. When these boards are scrapped and buried the Acid rain gradually dissolves the lead out of solder, and this makes the subsurface water becoming polluted with Pb compounds. The polluted subsurface water is taken into the human body as drinking water. Lead affects the Human nervous system and causes a range of serious problems, like the growth rate and intelligence are adversely affected as a result.

Lead free drivers:

Europe: European commission’s environment Directive (WEEE directive) emphasizes phase out, collection, recycling, bans the use of lead, and bans halogen flame retardants by July 1, 2006.

Japan: Voluntary compliance with Water Pollution Law, Air Pollution Law, Labor Safety Health Law beginning 2002-2003. Companies allowed to devise their own plan and most seem to be on track.

US: RCRA (Resource Conservation and Recovery Act) which implements mandatory take back after use (recycle). If lead removed no recycle required.

The legislation and directives mainly focus on two issues, the elimination of certain elements and compounds, and the recycling of products at "end of life". Elimination of the below mentioned materials will be the Primary effort in case of Semiconductor assembly.

Element / Compound Limit

		Element / Compound	Limit
1	Lead Free	Pb	1000 ppm
2	RoHS Compliant	Pb	1000 ppm
		Hg	1000 ppm
		Cadmium	100 ppm
		Cr	1000 ppm
		Polybrominated biphenyl	1000 ppm
		Polybrominated diphenyl ether	1000 ppm
3	Fully Green	All of the above plus :	
		Bromine	900 ppm
		Chlorine	900 ppm
		Antimony	900 ppm

	TBTO	Not used
	Phosphorus	Not used

Impact on IC packaging:

The elimination of these elements and compounds will have quite a profound impact on the semiconductor packaging industry. Many existing assembly materials can no longer be used because they contain one or more of the banned substances. In addition, materials that do not contain any of the banned substances may be excluded because they cannot meet the increased board assembly and reliability requirements. These are a direct result of the higher reflow temperatures required by the new Pb free solders. Packaging materials are designed to meet very strict reliability and performance requirements. The required changes to the material formulation, coupled with the need for a performance increase, translate to a total redesign of IC packages.

Elimination of Pb:

The most common of the solder alloys proposed for Pb free assemblies are ternary combinations of tin, silver and copper. These alloys typically contain 3 - 4% silver, 0.5 - 1.0% copper, with the remainder being tin. With melting ranges just below 220°C, versus eutectic tin/lead at 183°C, packages must be able to survi ve much higher temperatures during re flow assembly processing. Despite these more severe temperature exposures, the ternary Sn/Ag/Cu alloys are being used successfully in production. As a result, they are a natural choice to be used for solder balls on area array packages. Terminations for lead frame packages have historically been plated with a tin/lead solder of various compositions, typically in the range of 80 - 90% tin. Removal of the Pb from the package termination is not nearly as straightforward as with the solder balls for area array packages. The simplest solution would appear to be a pure Sn coating. Deposition processes are readily available, cost efficient, and a tin finish is compatible with both Pb free and tin/lead soldering processes. However, reliability concerns about tin whiskers is preventing universal acceptance of this solution.

Another viable option, with a long history in the industry, is nickel-palladium pre-plated lead frames. Available for more than 10 years now, this Pb free fi nish has not gained widespread acceptance. However, The Japanese electronics industry has used a higher percentage of these packages that any other market segment. Tin based coatings with a small amount of a non-lead metallic additive are also being considered as substitutes for lead based solders. Tin/bismuth, tin/copper and tin/silver are the most common options under consideration. Ternary-based coatings are not as viable due to the inherent problems with the deposition processes. Of these options, tin/bismuth has been adopted by a number of companies, mostly in the Japanese market.

Reliability requirements are being pushed to limit for Green electronic assemblies. Board assembly re flow processes are now required to maintain peak temperatures of 240 - 260°C. This can be as much as 20 -40°C higher than current processes. Creating a package that resists delamination under the added thermal and mechanical stresses calls for a new breed of materials.