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International Electronics Manufacturing Initiative

**Environmental
Regulations and
Materials
Technology in
the Electronics
Industry**

*Robert C. Pfahl
MRS Spring Meeting
April 11, 2007*

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Outline

- **Introduction to iNEMI**
- **Highlights from 2007 iNEMI Environmental Roadmap**
 - Increasing need for global harmonization
- **Pb-Free Conversion: Current Situation**
 - Industry readiness for EU and China RoHS
 - Evolving to a Pb-free Supply Chain
- **Next Steps**
 - Legislatively Driven Technology Needs Beyond RoHS
 - Proactive Evaluation of Alternative Flame Retardants
- **Summary and Conclusions**



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Introduction to iNEMI

- *Roadmapping the Industry Needs*
- *Closing the Gaps through Projects*

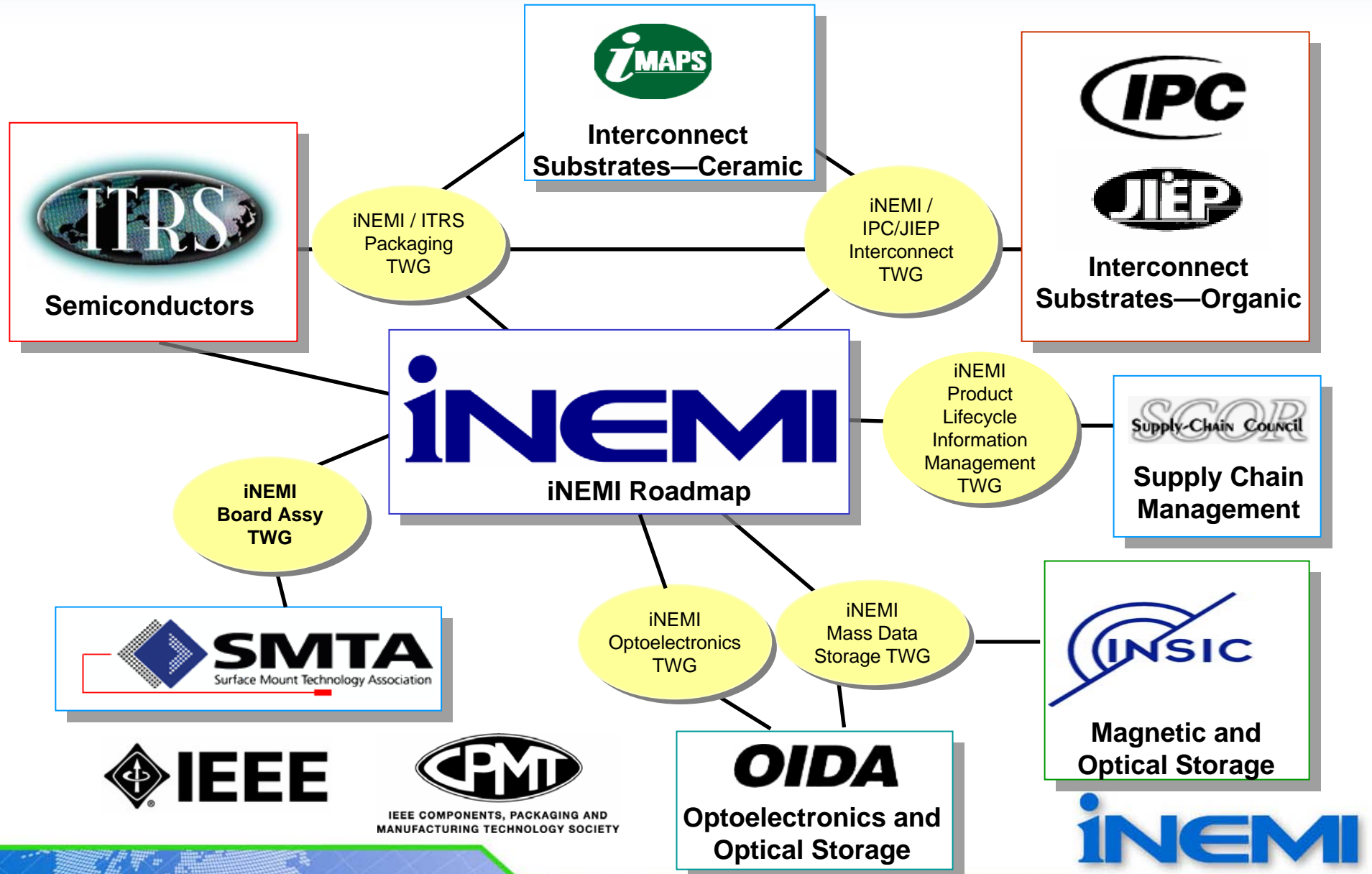
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2007 Roadmaps

19 Individual Roadmap Chapters

- Semiconductor Technology
- Packaging
- Mass data storage
- Board Assembly
- Final Assembly
- **Environmentally Conscious Electronics**
- Interconnect Substrates Organic
- Interconnect Substrates Ceramic
- Connectors
- RF Components & Subsystems
- Optoelectronics
- Passive Components
- Energy Storage Systems
- Organic & Printed Electronic
- Modeling, Simulation & Design Tools
- Thermal Management
- Test, Inspection & Measurement
- Product Lifecycle Information Management
- Sensors

9 Contributing Organizations



Statistics for the 2007 Roadmap

- **> 500 Participants**
- **> 265 Companies/organizations**
- **17 Countries from 4 Continents**
- **19 Technology Working Groups (TWGs)
(added Organic & Printed Electronics)**
- **5 Product Emulator Groups (PEGs)**
- **Over 1300 Pages of Information**
- **Roadmaps the needs for 2007-2017**

Research Priorities

- 2007 Gap analysis being completed
- 10 year priorities being created
- Distribute to members & others
- Contents:
 - Technology Research Needs by Product Sector
 - Priorities Summarized by Research Area
 - *Manufacturing Processes*
 - *System Integration*
 - *Materials & Reliability*
 - *Energy and the Environment*
 - *Design*
 - Significant Gaps and Issues from Roadmap
 - Options for Innovation





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Closing Gaps: Environmental Projects to Eliminate Pb Solder

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- **Participants:**
 - **iNEMI Members including:**
 - OEMs
 - EMS Firms
 - Suppliers
 - NIST
 - Universities
- **Environmental Objective**
 1. **Meet EU ROHS requirements**
 2. **Develop standard alloy to replace eutectic Sn-Pb**

Pb-Free Electronics-Actions Required

- **Research to identify viable alternatives**
- **Reliability studies on alternatives**
- **Selection of single alloy**
- **Process Development**
- **Material development (paste and flux)**
- **Application Development**
- **Identify the reliability risk of potential “whisker” growth from pure tin platings on components**
- **Reliability of solutions are on going**

Closing Gaps: Environmental Projects to Eliminate Pb Solder

- **1998 Roadmap identified the technology gap.**
- **Phase I project developed the alloy, process, components and reliability from 1999-2002.**

Results:

- **iNEMI efforts accelerated the establishment of SAC alloys as the standard and reduced the effort in each member company.**
- **Phase II projects expanded the technology base to include assembly and rework of large complex PWB assemblies and an understanding of tin whiskers.**



Closing Gaps: Environmental Projects to Eliminate Pb Solder

- **2002 Roadmap identified a number of business Issues to convert to a Pb-free supply chain.**
- **Five Phase III project teams addressed these supply chain transition issues.**
- **Four Phase IV projects are on going to close the following technology gap:**
 - **Wave/selective solder**
 - **Mixed assemblies (Pb-free BGA's in a SnPb assembly process)**
 - **Pb-free component surface finishes**
 - **Pb-free rework optimization**



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Highlights from 2007 iNEMI Environmental Roadmap

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2007 ECE Roadmap Focus Areas

To remain competitive, the electronics industry must continue to keep pace with emerging:

- **material restrictions,**
- **end-of life requirements,**
- **customer preferences for energy efficient products,**
- **holistic design requirements.**

At the same time the industry must meet increasing performance and reliability requirements:

- **many electronic materials will change over the next decade.**

Strategic Issues from ECE Roadmap

1. To minimize supply chain chaos and reduce the need to manufacture region-specific products it is critical that emerging international requirements of a given topic do not substantially differ in scope. **Harmonization through international standardization is essential. It is equally important that industry harmonize its technical responses.**
2. The area of Corporate Social Responsibility (CSR) is being driven by multiple factors, including globalization of the world economy, the failure of firms to effectively police themselves and the ability of the Internet to provide almost instant access to information. With environment as one of the pillars of CSR and an area of increasing global concern, there will be **increasing need to demonstrate that a firm is actively engaged.**

Strategic Issues from ECE Roadmap

An Increasing Need To Influence & Optimize The Global Regulatory Process:

- 1. Set Regulatory Goals Which Allow Flexible Compliance Strategies**
 - Recognize Diversity Of Products & Business Operations
- 2. Support Harmonized International Standards**
 - Standards Effectively Preserve Regulatory Objectives
 - Can Be Integrated Efficiently Across Different Business Models And Extended Supply Chains
 - Ensures The Benefits Of Technology Reach Consumers & The Community In The Most Efficient Way.



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Pb-free Conversion: Current Situation

- *High Volume Market has converted*
- *High Rel. Market has not converted*

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Industry In Transition

- **9 of 11 Telecommunications OEMs Polled took Pb-free Exemption for Solder In Network Infrastructure Equipment.**
- **A dual component supply chain has resulted:**
 - **Pb-free components for high volume consumer market**
 - **Traditional SnPb components for**
 - **Telecommunications**
 - **Servers**
 - **Military products**
 - **Medical electronics**
- **Reliability of Pb-Free Components with Eutectic Solder has not been fully demonstrated for long life products.**
- **The high rel. users have enjoyed the technology, availability, and low cost of consumer driven components:**
 - **Would like to continue to do so!**
- **Consensus is needed on remaining knowledge gaps and what must be done to reduce risk**

Scenarios

- **Long term solution is to reduce reliability risk of Pb-free components and assembly.**
 - The economic incentive is compelling
 - Well worth technology investment
 - Could take several years to complete but this is cumulative, so strides made today are useable.
- **What can we do in the short term to help encourage the availability of SnPb compatible BGAs?**
- **What can we do in the mid term to close remaining knowledge gaps that the High Rel. segments face?**
- **What can be done longer term to better understand and predict reliability of electronics hardware using Pb-free components and assembly?**

Additional Current Issues

- **Proliferation of Pb-Free metallurgies is significantly complicating the issue of closing knowledge gaps!**
 - Major issue today with BGA sphere and wave solder
 - Alloys behave differently
 - Can effect form/fit/function
 - supplier A part does not behave like supplier B part in mfg. and/or use.
 - Users are demanding new part numbers from their suppliers
- **Transition in Reliability Concerns**
 - Initial concerns with SAC alloys were thermal cycling
 - Current concern is mechanical failure.



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Next Steps Beyond RoHS

iNEMI-IPC
“Life After EU RoHS”
Forum

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Objectives of the Forum

- **Provide a broad overview of the evolving regulatory environment, including the current status of, and issues relating to, the emerging environmental regulations that the electronics industry is preparing for:**
 - China RoHS
 - EU REACH
 - EU EuP
 - Other environmental regulations (e.g., state laws in the United States)
- **Share information about industry efforts underway:**
 - Policy monitoring
 - Policy advocacy
- **Identify gaps that remain to be closed:**
 - Policy
 - Technology
 - Identify potential new efforts to close the identified gaps

Meeting Format

- **Global Overview and European Regulations (RoHS, EuP, REACH)**
 - JP Brisson, Allen & Overy
- **China RoHS**
 - Tom Valliere, Design Chain Associates
- **North & South American Regulations**
 - Fern Abrams, IPC
- **iNEMI Proactive Approach**
 - Bob Pfahl, iNEMI
- **Panel Discussion**
 - All Speakers

Conclusions from Forum

- There are no new major technology challenges from **China RoHS**.
 - Six substances restricted in China RoHS are common with EU RoHS (as well as concentration values).
 - Mandatory government testing is anticipated for China RoHS (no self declarations).
 - China RoHS mandates unique product marking, product information and packaging labeling.
 - Currently no exemptions for China RoHS – but the restrictions only apply to product placed in the catalogue (TBD- but marking, information and packaging labeling required for ALL products).
- **EU Reach** will have a major impact on material suppliers, limited impact on OEMs
- OEMs are aware of and working **EU EuP** requirements
- Biggest new challenge facing supply chain beyond RoHS is the proliferation of Green Programs from OEMs, many of which are establishing unique requirements to differentiate their products and services. These programs continue to drive the discussion around the needs for greater materials content data.



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Proactive Evaluation of Alternative Flame Retardants

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Proactive Programs

“Industry should take a proactive approach, work with stakeholders, and direct our activities where there is technical/ecological evidence we could and should be doing a better job to protect the environment. We should involve stakeholders in the process of evaluating alternative technologies to determine trade-offs between product functionality, environmental impact, reliability, safety, and cost.” Bob Pfahl/Joe Johnson

Bromine Free Substrates

- **Participants:**
 - **US EPA**
 - **Electronics industry through iNEMI**
 - **Other Stakeholders including NGOs**
- **Environmental Objective**
 - **Evaluate environmental risk of brominated and alternative flame retardants in PWB substrates**
- **Unique Characteristics**
 - **Industry lead proactive study to evaluate:**
 - **The technology risks of alternatives**
 - **EPA lead partnership to evaluate:**
 - **The environmental risks**

iNEMI Halogen-free Project

Project Objectives:

- **Build on industry knowledge and capability,**
- **Consider unique market segment requirements,**
- **Identify technology readiness and gaps,**
- **Stimulate supply capability, and**
- **Recommend standards development opportunities**

US EPA Design for Environment Program: Alternatives Assessment of Flame Retardants for Electronics Industry

- **Goal:** To identify and evaluate commercially available flame retardants and their environmental, human health and safety and environmental fate aspects in FR-4 printed circuit boards.
- **Scope:** The partnership will incorporate life-cycle thinking into the project as it explores the potential hazards associated with flame retardants and potential exposures throughout the life cycle of flame retardants as used in FR-4 printed circuit boards. As appropriate, the scope will include aspects of the life cycle where public and occupational exposures could occur. For example, consideration of **exposures from incineration or burning at the end of life will be included**, as will exposures from manufacturing and use.

Participants and Roles

EPA is encouraging the participation of individuals from different disciplines & interests to contribute on a range of tasks.

- **Participants to date include:**
 - **OEMs (environmental & product safety representation) and trade associations**
 - **Component and board manufacturers**
 - **Chemical companies (raw material suppliers, flame retardant suppliers, etc) and trade associations**
 - **NGOs – environmental groups, worker unions**
 - **Standards organizations**
 - **Universities**
 - **Governments – US EPA and Sweden Keml**
- **Other participants could include:**
 - **Federal governments**
 - **State governments**
 - **Local governments**
 - **Other national governments**
 - **Electronics recyclers**
 - **Public interest groups**

Summary of Proactive Approach

- **Search for Environmentally Benign Alternatives Should be Based on Good Science and Technology.**
- **Technology and business risks and the impacts of original process/materials and alternatives should be evaluated prior to legislative action.**
- **Voluntary programs have been effective in the electronics industry.**
- **Stakeholders should be involved in the process from the beginning (Both within the firm and within the community).**



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Summary and Conclusions

- *Roadmapping the Industry Needs*
- *Closing the Gaps through Projects*

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Facts/Challenges to the Industry

- **Electronic Materials will continue to be modified:**
 - **Reliability verification of these changes is crucial.**
- **Consumer Electronics drive the cost and the market:**
 - **High rel. market must develop a viable scenario to:**
 - **Take advantage of consumer components,**
 - **Meet their reliability requirements.**
- **Firms are expected to be Socially Responsible:**
 - **Industry must establish proactive, science-based programs to address potential environmental risks.**
 - **Stakeholders must be involved in the process from the beginning!**



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