PBTs in Products
International Materials Restrictions and Progress on Alternatives

NEWMOA Web Conference
11 Feb 2003

Liz Harriman
Massachusetts Toxics Use Reduction Institute

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Lead/PBTs – Drivers and Alternatives

- *Closing and Greening the Materials Loop*
- Toxic Chemical Use in Massachusetts
- Drivers for Change – EU Legislation
- Electronics Industry – solder alternatives
- Coated Wire and Cable (Plastics) Industry - Lead and BFRs

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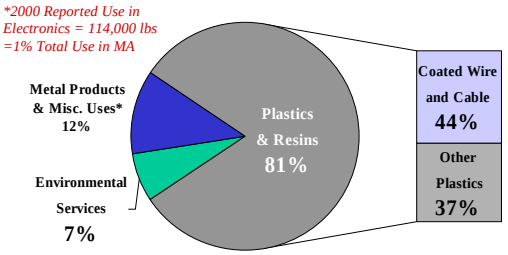
2

2000 Lead Use in Massachusetts

**2000 Reported Use in Electronics = 114,000 lbs =1% Total Use in MA*



Total 2000 Lead and Lead Compounds Use = 11 million lbs

3

"Drivers for Change"

- *Closing the materials loop and making it safer*

Update→ • European pending regulations – WEEE, RoHS

- Japanese take-back and recycling laws
- Japanese Mfr. Green Product & Lead-free initiatives

Update→ • California Prop 65 labeling

- Market forces for green labeling & take-back
- US focus on PBTs, TRI Lead reporting threshold

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European Community Directives

- Objective: reduce solid waste, encourage re-use and recycling, make recycling and disposal safer

Update→ • Waste Electrical and Electronic Equipment Directive (WEEE)

Update→ • Restriction on Hazardous Substances Directive (RoHS)

  – Status: both proposals approved

- EU End-of-Life Vehicle Directive

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5

WEEE Electrical & Electronic Equipment

1. Large household appliances
2. Small household appliances
3. IT and telecommunications equipment
4. Consumer equipment
5. Lighting equipment
6. Electrical and electronic tools (with the exception of large-scale stationary industrial tools)
7. Toys, leisure and sports equipment
8. Medical devices (with the exception of all implanted and infected products)
9. Monitoring and control instruments
10. Automatic dispensers

6

WEEE: Selective Treatment

- Mercury-containing components
- Batteries
- PWB's
- Toner cartridges
- Plastics containing BFRs
- CRTs
- External electrical cables
- others

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7

European Commission
DG Environment

Sustainable Resources, Consumption and Waste

Implementation scenarios:

Dec 2002 Adoption by Council and Parliament

Mar 2003 Publication and entry into force

Sep 2004 Deadline for transposition in Member States

Sep 2005 Collection systems must be operational; treatment and financing obligations enter into force

Dec 2006 Collection and financing targets to be attained

How the Directive is going to be implemented in detail is a matter for the Member States

Courtesy of Aaron McLoughlin, European Commission DG Environment

8

European RoHS

- Phase out lead, mercury, cadmium, hexavalent chromium, and certain PBB/PBDE brominated flame retardants
- Phase-out date 1 Jan 2006
- Broad coverage, but with specific exemptions

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9

Brominated Flame Retardants

- PDBE's :Polybrominated diphenyl ethers
  - Incl. Deca-, Octa- and Penta- congener blends
  - Octa and Penta risk assessments complete, conclusion to phase-out
  - Deca risk assessment not complete, may be exempt from RoHS
- PBB's: Polybrominated biphenyls (no longer produced)

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10

RoHS Exemptions

- Mercury in fluorescent lamps
- Lead in CRTs
- Lead as alloying element in small %
- Lead solder:
  - high melting point solder
  - In servers, storage, network infrastructure
- Some anti-corrosion applications of hex-Cr and Cd

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11

Where is Lead Used in Electronics?

- PWB manufacture
  - etch resist, surface finish, (finsihed boards are typ. 1% lead)

Update→ • PWB assembly
  - through hole and surface mount soldering, component attachment

- CRT manufacture
- Other:
  - coating of lead on components,
  - shielding,
  - cable coating, stabilizers and pigments in plastics

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12

Lead-Free Electronics – R&D

- UML Lead-Free Electronics Consortium
  - Phase II Test Program
    - Test matrix: 5 surface finishes, 3 SnCuAg solder pastes, Air vs. Nitrogen, many different components and finishes
    - Visual inspection complete
    - Next: pull testing of component leads
    - Thermal cycling and further testing

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13

Lead-Free Electronics – Supply Chain

- TURI Lead-Free Electronics Supply Chain Workgroup
  - Next meeting this spring
    - Tin whiskers
    - EPA/IPC Substitution Assessment
    - Consortium update

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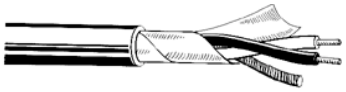
Wire and Cable

- Conductor
- Insulation
- Jacketing



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15

Wire and Cable Coating Materials

Resins + Additives = f (cost, performance)

Resins
- PVC, PE, Polyurethane, PP, FEP, CSPE
- EPDM, EPR, etc.

Update→ Additives
- Flame, heat, plasticizers, fillers, lubricants, colorants

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16

Materials of Concern

Update→ • Heat Stabilizers (PVC, rubber elastomers)
- Lead and Lead compounds

Update→ • Fire Retardants
- Antimony and Antimony compounds
- Brominated compounds (decabromo DBDPO, etc.)

- Plasticizers (PVC)
  - Phthalates –DIDP, DEHP, DINP
- Colorants
  - Heavy metals (Pb, Cr, Co, Ni, Cd)
- Halogens in Resins – Cl in PVC, Fl in fluoropolymers

17

Lead in Plastics – California Proposition 65

- Wire and Cable manufacturers worked through NEMA to agree on settlement
  - Limits % lead for different applications to avoid labeling requirements
  - Protects NEMA parties from suits for past violations of Prop 65

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18

PVC Lead Substitutes

- Challenges
  - cost, processability, formulation changes, wet applications
  - Calcium/zinc soaps
  - Magnesium-aluminum carbonates
  - Barium/zinc combinations
  - Organotin derivatives
  - Organic compounds (completely metal-free)
- Suppliers have many products already on market
  - MA OTA working with companies to switch where possible

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19

Lead Substitutes - Research

- Research at UML sponsored by TURI and OTA to determine mechanism of lead stabilizers in wet applications.

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20

Fire Retardants

There are a number of different "families" of flame retardants:

- Brominated
- Chlorinated
- Phosphorous-containing
- Nitrogen-containing
- Inorganic

Update –

flame retardant depends on application.

- subject to variables such as the material to be flame-retarded
- fire safety standards with which the product must comply, cost considerations, etc.

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21

Focus on BFRs

- Fire safety vs. health risk (EU vs US)
- Focus on brominated flame retardants
  - PBTs
  - 1998 Swedish PBDE breast milk study: 20yrs exponential growth, double 5 yrs
  - Many questions about BFR persistence, toxicity and risk

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22

Brominated Flame Retardants

- Br bisphenols (Tetrabromobisphenol-A TBBPA)
- Polybrominated diphenyl ethers (PBDEs)
  - Incl. Deca-, Octa- and Penta- congener blends
- Hexabromocyclododecane (HBCD)
- Polybrominated biphenyls (no longer produced) (PBBs)
- others

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Major BFR Uses

Source: McDonald – Cal EPA

BFR	Consumer materials (% of product)	Reactivity in matrix
PBDE penta-BDE	**polyurethane foam (<30%)**	**not bound**
PBDE octa-BDE deca-BDE	**plastics (<20%), rubbers (6%), textiles**	**not bound**
TBBPA	**plastics, resins, textiles**	**covalently bound**
HBCD	**plastics, polystyrene padding (1%), textiles, latex**	**not bound**

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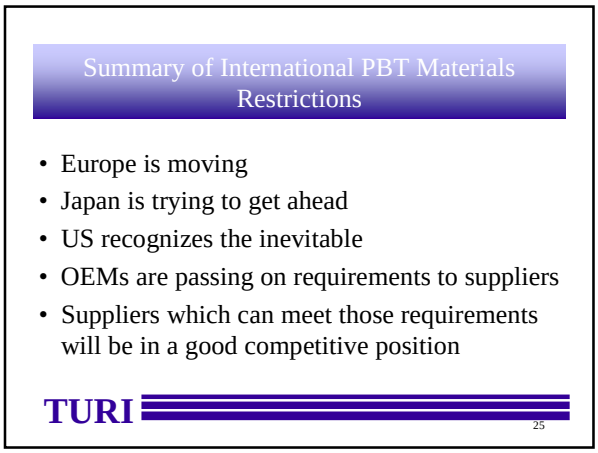
Summary of International PBT Materials Restrictions
• Europe is moving
• Japan is trying to get ahead
• US recognizes the inevitable
• OEMs are passing on requirements to suppliers
• Suppliers which can meet those requirements will be in a good competitive position
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25