Low environmental impact packaging

Presentation to SRC Packaging TAB – 7-14-22

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Agenda

- Change example
- Global thinking about products
- Government supply chain management tactic
- Sources of change pressure
- Disruption pain
- Opportunities
- Lemons to lemonade
- PFAS consortia
- Energizing thoughts
- Request to TAB
- Quiz (Yes there is a test!)

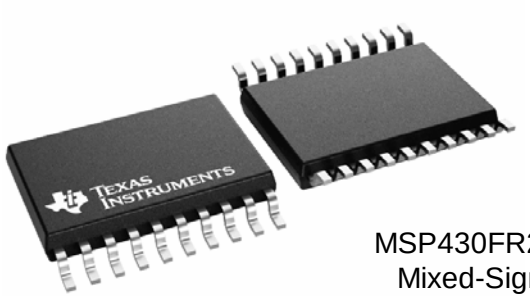
Change example: Bromine

Spectral lines of bromine

- Toxic and bioaccumulative
  - Tetrabromobisphenol A (TBBPA), 1,2,5,6,9,10- hexabromocyclododecanes (HBCDs: a-HBCD + P-HBCD + y-HBCD), and polybrominated diphenyl ethers (PBDEs) are highly lipophilic persistent organic pollutants (POPs) which have been identified in the aquatic and terrestrial environment including wildlife and humans[1-3]
  - The estimated terminal t/H of TBBPA in blood serum of humans (3.5 days) is in excellent agreement with the experimental t/H value (2.2 days; 95% CI 1.4-2.9 days) in blood serum of workers at an electronics dismantling plant.[4]
- Industry pivoted to non-toxic metal oxides
  - Costs: slow phase out and replacement – somewhat painful but workable
  - New industry around alternatives – win
  - New products wanted by OEM's – win
  - New products supplied by IDM's – win

Global Env thinking around product

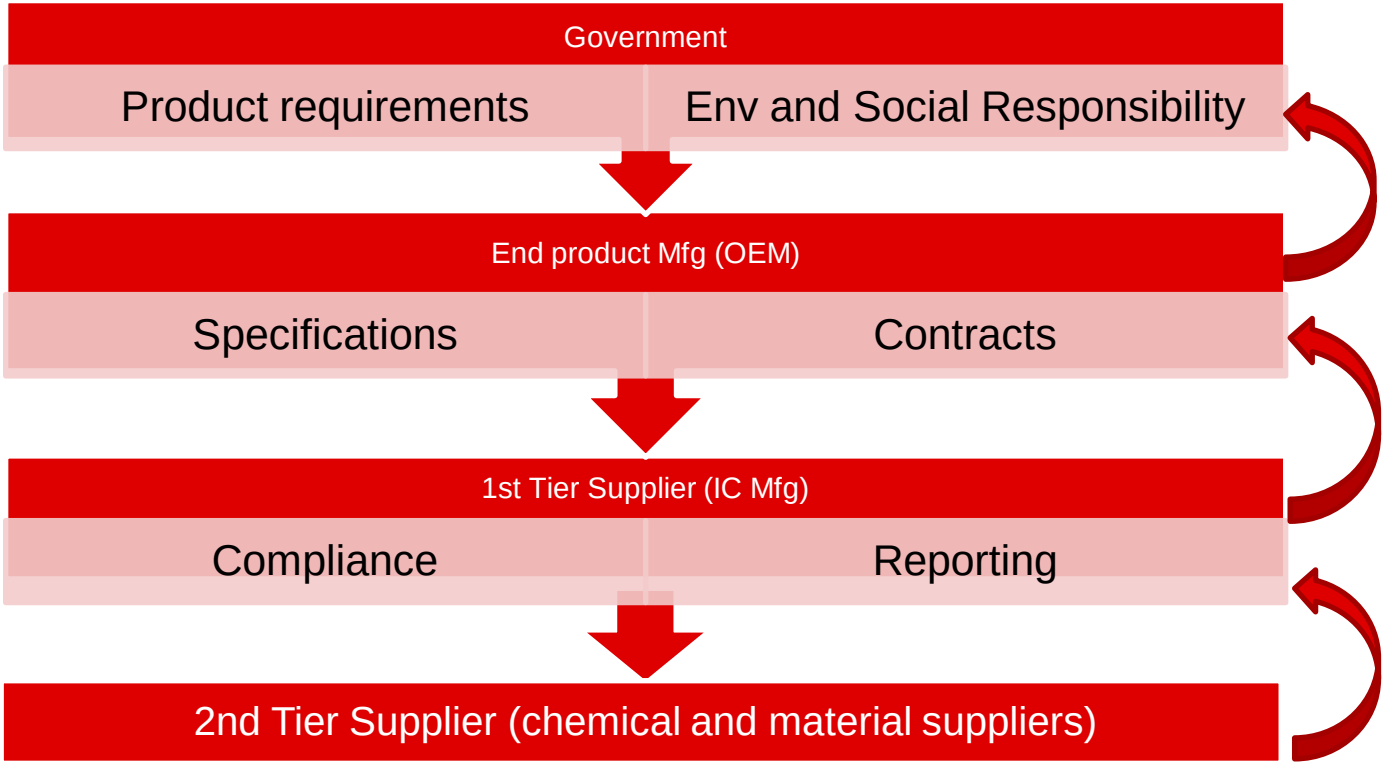
- Describing composition to customers or governments
  - Some metals - leads/wire, solder, heat sinks, etc.
  - Plastics / organics - adhesives, underfills, molds, coatings, substrates
- Typically the die is one of the smallest w/w components in the IC
  - As much as >99% package
- e.g. MSP430
  - Wire 0.07%
  - Adhesive 0.4%
  - Mold compound 38%
  - Lead frame 60%
  - Die 1.8%



MSP430FR231x
Mixed-Signal
Microcontroller

- Environmentally speaking – the package is the product

Government supply chain management tactic



Data and info

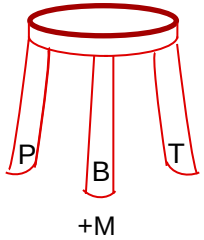
Sources of change pressure

Public stakeholders

- Why are there chemicals in my body?
- How did they get there?
- Answer: usually ingestion is the exposure route

Solution: Government

Action – more substance controls and faster action



Primary focus - PBT's

- Persistent – stable molecules that resists normal biological degradation
- Bioaccumulative – long half life in humans (months to years)
- Toxic – even moderate toxicity is a concern coupled with the P & B aspects
- Or mobile – transported broadly

EU - REACH - Registration, Evaluation, Authorization of Chemicals

425 compounds on today's candidate list ~ 7000 proposed PFAS's (perfluoro alkyl substances)

UN Persistent Organic Pollutants (POP's) Treaty – list of 21 (contains two PFAS's)

Disruption pains

- Forced rapid qualification
  - Usually to solve a process or material failure – quality or performance concern
  - Solution is usually known
  - A performance parameter may suffer
  - Leads to new uncertainties – all those unknowns!
  - Never enough time
  - Communication of change down the supply chain – who looks bad to the customer?
- As the lists grow, we should expect more of these
  - Faster pace with shorter data and change windows
- How much does one of these really cost?
  - Development time $$$
  - Qualification $$$
  - Lost production $$$$$
  - Lost sales $$$$$$
  - Lost trust $$$$$$$$$

Opportunities

- Full understanding of product content is now required for compliance
  - EPA leadership and REACH do not accept lack of knowledge in articles as a reason for an OEM to not report substances in products
    - e.g. PIP 3:1 wire coating FR (Phenol, isopropylated phosphate 3:1)
- Don’t know what we don’t know – IP constrains composition data flow
  - Need solutions to overcome IP barriers
  - Need more data about raw materials
- Considering polymers as a single molecule is not a safe haven
  - Monomer residues, plasticizers, polymerization processing aids
- Regulations are moving faster – data is needed to keep up

Lemons to lemonade

- Identify the risks in material sets and begin development work
- Control the change
- Rich data sets are necessary to communicate with governments and external stakeholders
- Work the problem collectively - work groups (peers, suppliers, customers):
  - Share the workload – leverage the volume of participants
  - Agree on what can be shared
  - Use 3rd parties to work IP in a protective way with owners
  - Surveys – develop information for what is known to identify unknowns
  - Create data rich papers for solutions or where solutions are needed
  - Rationalize the need for materials that can't be changed with performance requirements they meet
  - Prove it's the only thing that works ➡ this will highlight needed ESH controls and end-of-life solutions

PFAS consortia – example and opportunity

Per- and poly-fluoro alkyl substances (PFAS) are used in chemical formulations, components of manufacturing process tools, facilities infrastructure and packaging used to make the semiconductor devices that are integral to our modern world. Concerns regarding the persistence, mobility and potential toxicity of certain PFAS are driving governments across the globe to propose broad PFAS restrictions.

The semiconductor industry is an acknowledged global leader in promoting environmental sustainability in the design, manufacture, and use of its products, as well as the health and safety of its operations and impacts on workers in semiconductor facilities (fabs).

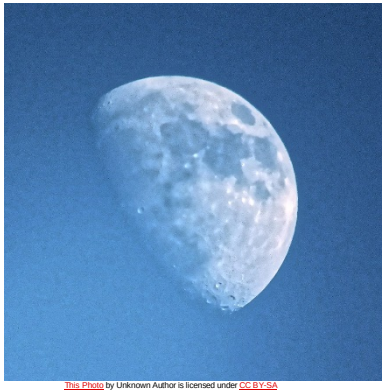
The industry and its key suppliers have formed a Semiconductor PFAS Consortium to collect the technical data needed to better inform public policy and legislation, including:

- Identification of critical uses,
- Application of the pollution prevention hierarchy to, where possible: reduce PFAS consumption or eliminate use, identify alternatives, and minimize and control emissions,
- Identification of research needs, and
- Development of socioeconomic impact assessments.

The consortium membership includes semiconductor manufacturers and members of the supply chain including chemical, material and equipment suppliers.

Energizing thoughts

- Challenge: look at each solutions with a biodegradable lens
  - i.e. consider the ESH impact as you work for new solutions
    - Manufacturing phase
      - emissions and
      - human protections
    - Product phase
      - uses by humans
      - end-of-product life impacts

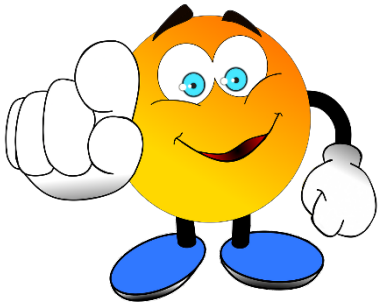


Aim at the moon and hit an eagle.
Aim at an eagle and hit a rock.

Native American proverb

Request to TAB

- Include foundation provisions in your Needs Document when you issue a call for papers
- Seek out and partner with your ESH experts working these issues
- Consider the ESH improvement aspects of the project work you fund
- The ESH TAB will assist as needed



Questions to the group

Quiz time!

1. PBT?
2. PFAS?
3. Key barrier to fast industry change?
4. Do you have project ideas for positive impact on component manufacturing use?

Thank you

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References

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