Hazardous elements in plastic and glass articles for food contact and storage

Andrew Turner
SoGEES
University of Plymouth
Plymouth PL4 8AA
aturner@Plymouth.ac.uk
Presentation outline

- Plastic additives
- Regulations for hazardous chemicals in plastics
- Source of hazardous chemicals in plastics
- Examples of contaminated food contact plastics
- Hazardous chemicals in glass
- Shortfalls of regulations
Plastic additives

- Anti-counterfeiting
- Anti-microbials
- Anti-oxidants
- Antistatic agents
- Blowing agents
- Fillers
- Impact modifiers

- Flame retardants
- Heat stabilisers
- Pigments
- Plasticisers
Regulations for hazardous chemicals in plastics

  - Cd, Pb, Cr(VI), Hg, BFRs in electronic plastic
  - Cd, Pb, Cr(VI), BFRs in computers
- **EU** (2011)
  - Cd, Pb, Cr(VI), Hg in consumer goods
  - Cd, Pb, Cr(VI), Hg in packaging/packaging waste
  - Cd, Pb, Cr(VI), Hg in plastic toys
  - Cd, Pb in plastic jewellery
  - Pb, Cr(VI) in food contact articles

- Packaging: Cd, Pb, Cr(VI), Hg = 100 µg g\(^{-1}\)
- Food contact: Pb = 2 µg g\(^{-1}\); Cr(VI) = 1 µg g\(^{-1}\)
EU RoHS Directive effective 1/7/2006

Restrictions on the use of Hazardous Substances in Electrical and Electronic Equipment (EEE)

RoHS compliance limits:
Br as certain BFRs = 1000 μg g⁻¹
Cd = 100 μg g⁻¹
Pb, Cr(VI), Hg = 1000 μg g⁻¹
Additives in electronic plastic:
Br - BFRs

Impurities in electronic plastic:
Pb – CRTs, solder, stabiliser for PVC
Cd – semiconductors, pigment in inks and paints
EEE ideal life cycle (closed loop)

1. WEEE -> baled and shipped
2. component separation
3. plastics
   - high temperature incineration
     - yes
     - no
6. BFR, Pb, Cd, Hg, Cr(VI)
7. recycling/reuse

Basel Convention?

(RoHS?)
WEEE plastics

EE

incineration

landfill

recycled

consumer products

consumer products

high temperature incineration

BFR, Pb, Cd, Hg, Cr(VI)

recycled

Basel Convention?

yes

no

EEE life cycle (open loop)

consumer products

EE

plastics

baled and shipped

WEEE

EE

recycling/reuse

EE

landfill

recycling/reuse

Basel Convention?
• Snip or burn/melt wires for Cu retrieval
• Wrench components from circuit boards
• Grind plastic
• Dissolve metals in HNO₃ or HCl
• Uncontrolled burning
Consequence:

Hazardous chemicals imported in consumer products (mainly “black”)

Infra-red sorters cannot detect black
Portable XRF spectrometry

Some matrix effects/interferences
Cannot discriminate Cr (III) / Cr (VI)
Cannot determine type of BFR from Br
PE, PP, PS, ABS
Cd, μg g⁻¹

53.1

<23

<28

<23

44.1

<23

148

81.8
Br, \( \mu g \, g^{-1} \)
Compliance with regulations

  - 2 non-compliant (Pb + Cd > 100 \( \mu g \) g\(^{-1} \))

  - >5 non-compliant (Pb > 2 \( \mu g \) g\(^{-1} \))

  - 2 potentially non-compliant (Br > 1000)
  - BFRs not regulated in food contact articles
Pb, Cd, Br never detected in PET
Decorated glassware for food and drink
Pb = 46,500 µg g\(^{-1}\) (overglaze)

Cd = 19,400 µg g\(^{-1}\) (heat resistant pigment)
Regulations for hazardous chemicals in plastics

  - Cd, Pb, Cr(VI), Hg, BFRs in electronic plastic
  - Cd, Pb, Cr(VI), BFRs in computers
- **EU** (2011)
  - Cd, Pb, Cr(VI), Hg in consumer goods
  - Cd, Pb, Cr(VI), Hg in packaging/packaging waste
  - Cd, Pb, Cr(VI), Hg, Sb in plastic toys
  - Cd, Pb in plastic jewellery
  - Pb, Cr(VI) in food contact articles

- **Packaging:** Cd, Pb, Cr(VI), Hg = 100 μg g⁻¹
- **Food contact:** Pb = 2 μg g⁻¹; Cr(VI) = 1 μg g⁻¹
Is the décor a separate component of the container?

Cd = 6900 μg g⁻¹
(unglazed pigment)

Cd when total mass accounted for ~ 50 μg g⁻¹

Human health risk and contamination of glass cullet
Conclusions and recommendations

- Recycled WEEE plastic appears to be the main source of hazardous contaminant in food contact plastics
- Largely limited to black plastics (non-PET)
- Cadmium and lead are deliberately added to glass containers for décor
- Regulations are needed to address:
  (i) Export of hazardous plastics
  (ii) Recycling of materials into products serving a different function
  (iii) Components of articles that pose a hazard