CHEMICALS IN PLASTICS
Health impacts throughout the lifecycle of plastics

https://www.ciel.org/plasticandhealth/

David Azoulay
Center for International Environmental Law

Sirine Rached
Global Alliance for incinerator Alternatives

Collaborative on health and the environment Webinar
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Polymers, additives and “other” substances

Thousands of additives for variety of functions (Phthalates, Brominated flame retardant, Lead compound, PoPs, antioxidants, stabilizers, color....). Up to 80% of the final product by mass (Some PVCs), but are around 20% on average.

Human exposure through variety of pathways

Fragmentation makes plastic bio available

Environmental plastics can leach toxic additives and concentrate toxins already in the environment

Lack of transparency makes risk assessment relating to plastics extremely limited
The life cycle approach

- Extraction
- Refining and manufacturing
- Consumer use
- Waste management
- Plastics in the environment
Plastic & Health: The Hidden Costs of a Plastic Planet

Humans are exposed to a large variety of toxic chemicals and microplastics through inhalation, ingestion, and direct skin contact, all along the plastic lifecycle.

**DIRECT EXPOSURE**
- **Extraction & Transport**
  - **Exposure:** Inhalation, ingestion, and skin contact due to air, water, and soil.
  - **Health:** Affects the immune system, nervous system, liver, and kidney. Impacts include cancer, heart, respiratory, and developmental toxicity.

- **Refining & Manufacture**
  - **Exposure:** Inhalation, ingestion, skin contact (air, water, and soil).
  - **Health:** Impacts include cancer, nervous system, reproductive toxicity, bone health, and skin irritation.

- **Consumer Use**
  - **Exposure:** Inhalation, ingestion, skin contact.
  - **Health:** Affects heart, lungs, and skin. Impacts include cancer, diabetes, and developmental toxicity.

- **Waste Management**
  - **Exposure:** Inhalation, ingestion, skin contact.
  - **Health:** Affects heart, lungs, and skin. Impacts include cancer, diabetes, and developmental toxicity.

**ENVIRONMENTAL EXPOSURE**
- **Microplastics (e.g., microbeads and microfibers) and toxic additives including POPS, BDEs, and alkylphenols**
  - **Exposure:** Inhalation and ingestion
  - **Health:** Affects the immune system, nervous system, respiratory system, reproductive system, and developmental toxicity

- **Plants**
  - **Exposure:** Ingestion
  - **Health:** Impacts include cancer, neurological damage, and respiratory damage

- **Air**
  - **Exposure:** Inhalation
  - **Health:** Impacts include cancer, neurological damage, and reproductive toxicity

- **Fresh Water & Oceans**
  - **Exposure:** Ingestion
  - **Health:** Impacts include cancer, neurological damage, and reproductive toxicity

**NEW**
- **Microplastics**
- **Chemicals**

Source: © 2021 Pathway Design
### Ranking of Some Plastic Polymer Types Based on Hazard Classification of Constituent Monomers

<table>
<thead>
<tr>
<th>Polymer</th>
<th>Monomers/Additives</th>
<th>Relative Hazard Score</th>
<th>Recycling Code</th>
<th>Constituents Measured in NHANES?</th>
</tr>
</thead>
<tbody>
<tr>
<td>Polyurethane PUR as a flexible foam</td>
<td>Propylene oxide, Ethylene oxide, Toluenes-diisocyanate</td>
<td>13,944</td>
<td>6</td>
<td></td>
</tr>
<tr>
<td>Polyurethane PUR as a rigid foam</td>
<td>Propylene oxide, 4,4-methylene-bisphenol diisocyanate (MDI), Cyclopentane</td>
<td>7,984</td>
<td>6</td>
<td></td>
</tr>
<tr>
<td>Epoxy resins DGEBA</td>
<td>Bisphenol A, Epichlorohydrin, 4,4'-diaminodiphenylmethane</td>
<td>7,139</td>
<td>7</td>
<td>Bisphenol A</td>
</tr>
<tr>
<td>Epoxy-glass</td>
<td>Acrylonitrile, Vinyl chloride, 1,3-butadiene</td>
<td>6,552</td>
<td>7</td>
<td>Styrene</td>
</tr>
<tr>
<td>Styrene-acylonitrile SAN</td>
<td>Styrene, Acrylonitrile, Acrylonitrile</td>
<td>2,768</td>
<td>7</td>
<td>Styrene</td>
</tr>
<tr>
<td>High impact polystyrene HIPS</td>
<td>Styrene, Acrylonitrile</td>
<td>1,628</td>
<td>7</td>
<td>Styrene</td>
</tr>
<tr>
<td>Polymers with the lowest relative hazard scores</td>
<td>Low density polyethylene LDPE, Ethylene</td>
<td>11</td>
<td>4</td>
<td></td>
</tr>
<tr>
<td>High density polyethylene HDPE</td>
<td>Ethylene, Ethylene</td>
<td>11</td>
<td>2</td>
<td></td>
</tr>
<tr>
<td>Polyethylene terephthalate PET</td>
<td>Terephthalic acid, Vinyl acetate, Polynesic acid</td>
<td>4</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>Polyvinyl acetate PVA</td>
<td>Vinyl acetate</td>
<td>1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Polypropylene PP</td>
<td>Propylene</td>
<td>1</td>
<td>5</td>
<td></td>
</tr>
</tbody>
</table>

### Common Toxic Chemical Additives to Plastic

<table>
<thead>
<tr>
<th>Toxic Chemical Additive</th>
<th>Products In Which They Can Be Found</th>
<th>Health Impact</th>
</tr>
</thead>
<tbody>
<tr>
<td>Acrylonitrile</td>
<td>Drinking cups, acrylic carpet and other textiles, plastic furniture, 3-D printing, automotive parts, and appliances.</td>
<td>Carcinogen</td>
</tr>
<tr>
<td>Bisphenol</td>
<td>Polycarbonate plastics, plastic tableware, dental fillings, and lenses for glasses. BPA is also used to make epoxy resins that are used as coatings in lids of glass containers and in the linings of aluminum cans. BPA is also used to coat some thermal papers.</td>
<td>BPA is an endocrine-disrupting chemical. Breast cancer, prostate cancer, endometriosis, heart disease, obesity, diabetes, altered immune system, and effects on reproduction have all been tied to BPA's ability to disrupt the normal functioning of endocrine systems. In young children, BPA exposures before and after birth are linked to changes in brain development and behavior.</td>
</tr>
<tr>
<td>Cadmium</td>
<td>Used as a colorant and stabilizer in plastic.</td>
<td>Lung cancer, endometrium, and bladder and breast cancer have been associated with cadmium. Cadmium can also damage the body's cardiovascular, renal, gastrointestinal, neurological, reproductive, and respiratory systems.</td>
</tr>
<tr>
<td>Flame retardants</td>
<td>Plastic-based home furnishings (foam, upholstery, curtains and blinds) and electronics (computers, laptops, phones, televisions, and household appliances).</td>
<td>Some flame retardants are endocrine-disrupting chemicals. Studies have also linked flame retardants to thyroid disruption, impacts on fertility and the functioning of the immune system, and harm to the development of babies’ brain and nervous systems both before and after birth. Several flame retardants are banned from production or use under the Stockholm Convention because they pose an unacceptable threat to human health and the environment.</td>
</tr>
<tr>
<td>Lead</td>
<td>Lead is used as plastic stabilizers and has been found in plastic jewelry, vinyl raingear, lunchboxes, and vinyl window blinds. In children, lead can cause reduced growth both before and after birth, decreased IQ and increased attention deficit and problem behaviors. In adults, lead exposures are linked to decreased kidney function and increased risk of hypertension, nerve disorders, and memory problems. There is no safe level of exposure to lead.</td>
<td>In children, lead can cause reduced growth both before and after birth, decreased IQ and increased attention deficit and problem behaviors. In adults, lead exposures are linked to decreased kidney function and increased risk of hypertension, nerve disorders, and memory problems. There is no safe level of exposure to lead.</td>
</tr>
<tr>
<td>Perfluorinated Substances (PFAs)</td>
<td>Grease and stain repellent in plastic-based fabrics used for raingear, upholstery, and carpeting, and as a plastic coating on cookware.</td>
<td>PFOA and PFOS are linked to human diseases including pregnancy complications, low birth weight, testicular and kidney cancer, and thyroid problems. The Stockholm Convention POPRC recommended not using any of the fluorinated alternatives to PFOA and PFOS, “due to their persistence and mobility as well as potential negative environmental, health, and socioeconomic impacts.”</td>
</tr>
<tr>
<td>Phthalates</td>
<td>Plasticizer used to make plastic soft and pliable.</td>
<td>Phthalates are endocrine disruptors. They harm the reproductive and nervous systems, especially in children before and after birth. Deformities of the penis and learning and behavior problems are all associated with phthalates exposure. Studies have also shown that the higher the levels of phthalates are in a home, the more likely children in that home are to have asthma or other respiratory conditions.</td>
</tr>
<tr>
<td>Styrene (also known as Vinyl Benzene)</td>
<td>Polystyrene plastics and expanded polystyrene.</td>
<td>Carcinogen</td>
</tr>
<tr>
<td>Vinyl Chloride</td>
<td>PVC: plastic furniture, carpet backing, packaging or wall covering.</td>
<td>Liver cancer</td>
</tr>
<tr>
<td>SCCP</td>
<td>Plastic consumer product, children's products.</td>
<td>SCCPs adversely affect the kidney, liver, and thyroid, disrupt endocrine function, and are believed to be human carcinogens.</td>
</tr>
</tbody>
</table>
FIGURE 7
Toxic Exposure from Incineration

MIXED WASTE

INCINERATOR

NO₂
VOCs
CO
PM
PAH
Dioxins & Furans
PCBs
CO₂
Methane
Aldehydes

Ozone

Brain: Neurological Systems
Respiratory Systems
Heart
Liver
Stomach
Reproductive Systems

Source: NonprofitDesign.com, adapted from Donn Moon/GAIA
By 2025, production capacity projected to grow by $\frac{1}{3}$rd for both ethylene and propylene.
• This new capacity would lock in a massive expansion of cheap plastic production for decades.

• If the boom is not addressed, it could largely undermine efforts to reduce plastics use and pollution.
Solutions and ways forward

Complex life cycle and variety of actors will require variety of solutions and options

- Put human health and human rights at the core of any future approaches
- Make the invisible visible – Transparency is key
- Avoid false solutions
- Think globally, act everywhere.
Triple COP, UNEA and beyond

**Stockholm**: Recycling exemptions and Low POPs waste

**Basel**: Norwegian amendment

**UNEA**: Process towards a new multilateral instrument on Plastic pollution

Learn more at [https://www.ciel.org/reports/unea-progress-on-plastics/](https://www.ciel.org/reports/unea-progress-on-plastics/)
The global plastic waste trade: Changes in international rules
The Basel Convention amendment

- Basel Convention 1.01: Green, Yellow and red list

Before the amendment

All plastic waste = Green list
(except hazardous as defined in annex 1 & 3)

Learn more @ https://wastetradestories.org/
After the Amendment

All plastic waste = yellow list except:

- Plastic waste almost exclusively consisting of ONE non halogenated polymer (PE, PP, PS, PP, ABS..)

- Mixtures of plastic wastes, consisting of polyethylene (PE), polypropylene (PP) or polyethylene terephthalate (PET), provided they are destined for separate recycling of each material and in an environmentally sound manner, and almost free from contamination and other types of wastes.

- Plastic waste almost exclusively consisting of ONE cured resin or condensation products

- Plastic waste almost exclusively consisting of ONE of the listed fluorinated waste

Provided it is destined for recycling in an environmentally sound manner and almost free from contamination and other types of wastes
More details at:


https://www.ciel.org/empowering-countries-stop-plastic-flood-basel-amendment/

Challenges ahead:
- Situation until entry into force, 1 Jan 2021
- Enforcement
- Revision of amendment (cured resins and fluorinated Polymers)
- plastic waste (co)incineration
THANK YOU FOR YOUR ATTENTION AND QUESTIONS

https://www.ciel.org/plasticandhealth/

Contact: David Azoulay
dazoulay@ciel.org

Sirine Rached
sirine@no-burn.org