Recycling of Plastics in the U.S.A.

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Outline

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Background

- In the early 1990s, interest to recycle post-consumer plastic food containers to new food packaging was driven by the perceived shortages of landfills for solid waste disposal
- A PET bottle was the first and continues to be post-consumer plastic container subjected to recycling for food applications, due to favorable market and economic incentives
- Other plastics (PS, PE and PP) are recycled but in smaller quantities than PET
- FDA supports recycling but the recycled material must be safe for food contact use

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Regulatory Framework

- No federal regulations (Title 21 of Code of Federal Regulations, denoted as 21 CFRs) explicitly address the use of post-consumer recycled plastics for food contact applications

- Must rely on 21 CFR 174.5 (general provisions applicable to indirect food additives)
  - 174.5(a)(2) states that "any substance used as a component of articles that contact food shall be of a purity suitable for its intended use"
  - Both polymer resins and any adjuvant incorporated into polymer resins meet the existing applicable authorizations

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FDA's Safety Concerns

- Contaminants from misuse (and nonfood containers)
- Adjuvants
  - present in the feedstock may not be approved for food contact use
  - present in the feedstock may react during recycling
  - added to the recycled polymer may not comply with the regulations for food-contact use

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FDA's Guidance Document

- Developed in 1992: "*Points to Consider for the Use of Recycled Plastics in Food Packaging: Chemistry considerations*"
- Updated in August 2006: "*Use of Recycled Plastics in Food Packaging" (www.fda.gov)*
- Addresses the chemistry issues – migration of chemical contaminants from post-consumer recycled plastics to food
- As contaminants are unknown, the guidance recommends a surrogate testing protocol for evaluating the efficacy of a proposed recycling process to remove chemical contaminants
- Establishes an acceptable upper-limit of dietary exposure to chemical contaminants from recycled plastic material
  - Based on 0.5 ppb dietary concentration (21 CFR 170.39, TOR for substances used in food contact articles)

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Surrogate Testing Protocols

- Conduct a challenge test (intentional contamination) using surrogates with various physical and chemical properties to simulate the incidental chemical contamination of the feedstock
  - Misuse of containers
  - Inclusion of nonfood containers
- Subject the challenged material to the proposed recycling process
- Analyze recycled material for residual surrogate levels

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FDA's Recommended Surrogates

Surrogate properties	Surrogate contaminants
Volatile, Polar	Chloroform Chlorobenzene 1,1,1-Trichloroethane Diethyl ketone
Volatile, Non-polar	Toluene
Non-volatile, Polar	Benzophenone Methyl salicylate
Non-volatile, Non-polar	Tetracosane Lindane Methyl stearate Phenylcyclohexane 1-Phenyldecane 2,4,6-Trichloroanisole
Heavy metal (not needed for PET only)	Copper (II)-2-ethylhexanoate

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Recycling Processes

- Primary recycling (1°): use of pre-consumer industrial scrap and salvage to form new packaging
- Secondary recycling (2°): physical reprocessing, typically involves aqueous washing, drying, and remelting and reforming
- Tertiary recycling (3°): chemical processing, e.g. hydrolysis, methanolysis, and glycolysis typically applied to PET and PEN, and involves
  - Depolymerization of post-consumer plastic to starting materials (monomers or oligomers)
  - Purification of the starting materials
  - Repolymerization of the starting materials to form regenerated polymer

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Recycling Submissions

- Voluntary submissions
- We evaluate the recycling process, and not the recycled product
- Information submitted:
  - Complete description of the proposed recycling process
  - Surrogate test results (except 3^{o} recycling for PET, PEN)
  - Dietary exposures (≤ 0.5 ppb) as determined by
    - Assumption of 100% migration
    - Migration testing
    - Migration modeling
    - Use of an effective barrier
- We issue a favorable opinion letter to the effective cleaning process

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FDA's No objection letters (NOLs)

Polymer	Secondary recycling processes		Tertiary recycling processes	Total NOLs*
	Monolayer	Effective barriers		
PET	75	14	18	107
PS	9	7		16
HDPE	6	2		8
PE/PP	4			4
PET Coatings**	4			4
PEN			1	1
Total NOLs*	98	23	19	140

Source: http://www.accessdata.fda.gov/scripts/fcn/fcnNavigation.cfm?rpt=recyListing (2/90-10/10)

** exterior coating. PCR-PET accounts for ~80%

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U.S. Recycling of PCR-Plastics (Estimated in 2008)

PET

- Production capacity (virgin + recycled) 3.7 M metric tons; recycling rate 9.1%
- PET bottles sold 2.6 M metric tons, only 25.5% recycled
- Consumption of recycled PET 0.43 M metric tons (net from recycled + import – export)
  - 40% fiber, 17% strapping, 16% sheet and film, 15% food and beverage bottles, 7% nonfood bottles, 5% others

Others

- Production capacity (M metric tons): 25. 7 for PE, 9.3 for PP, 3.3 for PS
- Recycling rate: 3.1% for PE, 1.2% for PP, 0.8% for PS
- Less likely used for food packaging

Sources: Chemical Economics Handbook (CEH), February 2009

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Conclusions/Trends

- High crude oil prices mean higher prices of virgin plastic resins, making recycled plastics more competitive
- PET recycling submissions to FDA review still dominate
- Most are secondary recycling processes, so-called 'Super Clean' (proprietary thermal decontamination steps, e.g. solid state polycondensation (SSP) applied to PET)
- Use of mixed feedstock (food and non-food containers) excluding industrial containers
- More migration models are used for estimating migration levels to show a dietary concentration (DC) < 0.5 ppb

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Thank You

Any Questions?