

**Environmental, Safety and Health
Evaluations of Perfluoroalkanesulfonyl
(PFAS) Based Surfactants for
Semiconductor and Microelectronics
Manufacturing**

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ERC Teleseminar Agenda

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- 1) 3M Surfactant Product Development Approach**
- 2) Ecotoxicity Data**
- 3) Mammalian Toxicity Data**
- 4) Bioconcentration Data**
- 5) Conclusions**

Fluorinated Surfactants in the IC Wafer Fab

- **Fluorinated Surfactants are critical components in a variety of IC manufacture process steps**
 - **Photolithography, Wet Etch, Plating, Wafer Cleaning**
- **“PFAS” terminology - Perfluoroalkylsulfonates**
- **A new family of fluorinated surfactants are being developed to meet the IC industry’s EHS requirements.**

Common Questions

Q: Are these new surfactants “PFAS”?

A: Yes.

Q: Are these new surfactants considered PBTs under the EPA’s PBT Policy (Persistent, Bioaccumulative, and Toxic Chemical Policy)?

A: No.

3M Product Development Approach

- **Life Cycle Management Process**
- **Important Criteria**
 - **Working with Customers on Applications**
 - **EHS Profile**
 - Effects**
 - Accumulation Properties**
 - **Stability and Ultimate Fate**
 - Product**
 - Residuals**
 - Degradation By-Products**
 - **Exposure and Release Potential**
 - **Ability to Manage/Control Exposure/Releases**

EHS DATA OVERVIEW OF NEW FLUOROCHEMICAL TECHNOLOGY

- Favorable Environmental, Health, and Safety profile of Perfluorobutane Sulfonate (PFBS) based surfactants**
 - Surfactants are Stable Polymers/Molecules**
 - The Ultimate Degradation Product, Perfluorobutane Sulfonate, has Low Mammalian Toxicity, Low Ecotoxicity, Low Bioaccumulation Potential**

Environmental Testing Results for PFBS

Acute Ecotoxicity

		PFBS
Microbial (OECD 209)	3-hr EC ₅₀ (mg/L)	>1000
<i>Selenastrum capricornutum</i> (algae)	96-hr EC ₅₀ Growth rate (mg/L) Cell density (mg/L) Area under curve (mg/L)	>1000 >1000 >1000
<i>Daphnia magna</i>	48-hr EC ₅₀ (mg/L)	>1000
<i>Mysidopsis bahia</i> (small salt water shrimp)	96-hr EC ₅₀ (mg/L)	100-1000
Bluegill sunfish	96-hr LC ₅₀ (mg/L)	>1000
Fathead minnow	96-hr LC ₅₀ (mg/L)	>1000

Acute Toxicity in Fish/Daphnia/Algae

Toxicity Value mg/L	NIOSH	European Union
< 1	Highly Toxic	Very Toxic
1-10	Moderately Toxic	Toxic
10-100	Slightly Toxic	Harmful
100-1000	Practically Non-Toxic	----
> 1000	Insignificant Hazard	----

Acute Mammalian Toxicity Studies for PFBS

<u>Study</u>	<u>PFBS</u>
Skin Irritation	Non-Irritating
Eye Irritation	Moderate
Ames	Negative
Chromosomal Aberration	Negative
Teratology	Negative
Acute Oral LD ₅₀ (mg/kg)	> 2000

Acute Toxicity in Rat

Toxicity Value mg/kg	European Union	EPA 8(e) Criteria
< 25	Very Toxic	----
25-200	Toxic	----
200-2000	Harmful	----
> 2000	No Hazard Statement	----
< 5	----	Extremely Toxic
5-50	----	Highly Toxic
50-500	----	Moderately Toxic
> 500	----	Slightly Toxic

Chronic Mammalian Toxicity Studies for PFBS

<u>Study</u>	<u>PFBS</u>
2-Generation Reproduction-Rat (NOEL, mg/kg/day)	> 1000

BCF Rainbow Trout

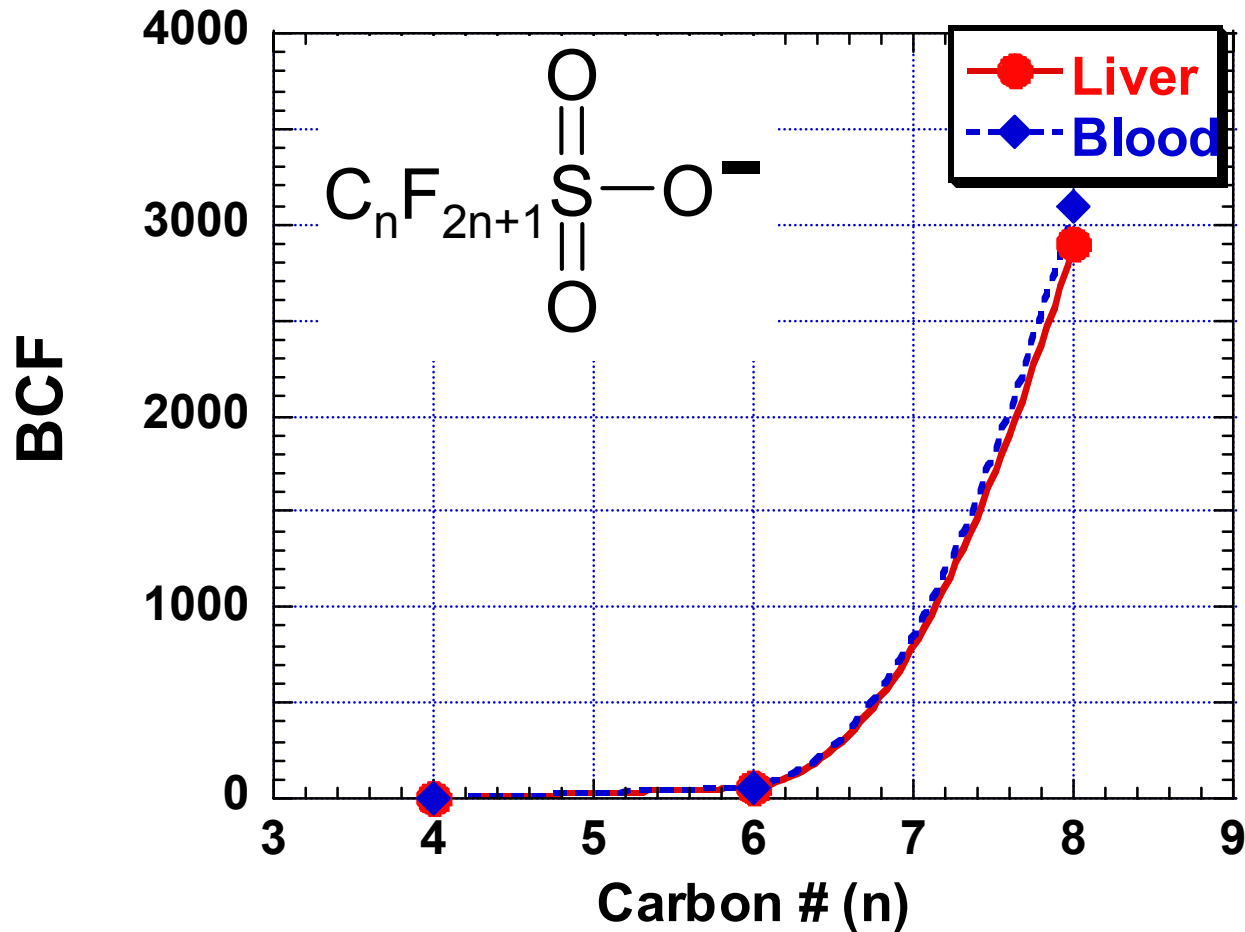
<u>Chemical</u>	<u>Liver</u>	<u>Blood</u>
PFBS (C ₄)	< 1	< 1
PFHS (C ₆)	54	59
PFOS (C ₈)	2,900	3,100
PFOA (C ₈)	12	25
PFDA (C ₁₀)	1,100	1,900
PFUNA (C ₁₁)	3,800	5,500
PFDOA (C ₁₂)	11,000	18,000
PFTA (C ₁₄)	8,700	20,000

BCF-BioConcentration Factor

Martin JW, Mabury SA, Solomon KR, Muir DCG. 2001. Bioconcentration and tissue distribution of perfluorinated acids in rainbow trout (*Oncorhynchus mykiss*). Submitted to Environ. Toxicol. Chem.

BCF Rainbow Trout

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BCF Criteria

Program

BCF Value

EPA TSCA PMN Review

**100-1000 Medium Concern
1000 High Concern**

Canadian Programs

**> 500 Medium Concern
> 1000 High Concern
> 5000 Highest Concern**

EPA PBT Policy

**> 1000 High Concern-
Additional Review
> 5000 Deny Commercialization
Pending Testing**

**Great Lakes Water Quality
Initiative**

**> 1000 Considered Chemicals
of Concern**

CONCLUSIONS

- 1. 3M committed to providing sustainable products from an EHS perspective**
- 2. Significant level of testing completed**
- 3. PFBS based chemistry exhibits favorable EHS characteristics**
- 4. The first series of PFBS based surfactants have been approved for commercialization with a high level of scrutiny and are not considered to be PBTs.**
- 5. PFBS based surfactants provides a favorable alternative to other fluorochemicals in the marketplace**

Common Questions

Q: Are these new surfactants “PFAS”?

A: Yes.

“PFAS” stands for perfluoroalkanesulfonyl or perfluoroalkanesulfonate. The new surfactants contain a perfluorobutanesulfonyl (PFBS) group.

Q: Are these new surfactants considered PBTs under the EPA's PBT Policy?

A: No.

These new (PFBS) surfactants are practically non-toxic and have negligible potential to bioconcentrate.