BMF 103 | 0423

Bisphenols

Bisphenols are a group of chemicals used to manufacture polycarbonate plastics and epoxy resins applied in consumer products, including food and beverage can liners and plastic water bottles. Though their health effects are still debated, there is concern about bisphenols, such as the commonly used bisphenol A (BPA) chemical, and its impact on human health and the environment. The U.S. Environmental Protection Agency (EPA) has referred to BPA as a 'reproductive, developmental, and systemic toxicant'. [1]

What are bisphenols?

Bisphenols are a group of chemicals used to manufacture polycarbonate plastics and epoxy resins which are used in consumer products in nearly every industry. Bisphenol A (BPA), one of the most widely used chemicals in this group, was initially investigated for pharmaceutical use as synthetic oestrogen in the 1930s.[2]

Many plastic products marketed as BPA-free contain similar replacement chemicals. The European Chemicals Agency (ECHA) has grouped together 148 structurally similar substances and recommended that more that more than 30 bisphenols need to be restricted due to potential hormonal and reproductive effects.[16]

General structure:

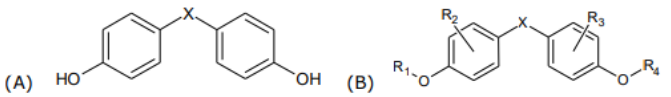


Figure: Generic "bisphenol" structure (A) with "X" depicting the bridge between the phenyl rings. There may be additional groups attached to the bridging atom(s). (B) General "bisphenol derivative" structure. R_n can be the same/different groups. R_n does not cover halogen substituents.

European Chemicals Agency, Assessment of regulatory needs [16]

What are the concerns?

Health concerns

Though the health effects of bisphenols are still debated, it is thought that the synthetic chemical, BPA, weakly mimics the human hormone oestrogen, potentially causing adverse health effects. [7]

Environmental concerns

The Environmental Protection Agency (EPA) has raised concerns about BPA because it is a 'reproductive, developmental, and systemic toxicant in animal studies and is weakly oestrogenic'. [1]

An EPA report indicates that 'levels of BPA in humans and the environment are below levels of potential concern for adverse effects', but added that 'results of some recent studies' using low-dose approaches 'describe subtle effects in laboratory animals at very low concentrations'. [1]

There is growing concern because 'concentration levels identified with effects are similar to some current environmental levels to which sensitive aquatic organisms may be exposed'. [1]

Brominated bisphenols are high volume compounds used as flame retardants. There has been concern raised in relation to the flame retardant, 3,3',5,5'-tetrabromobisphenol A (TBBPA), which is now on the ECHA's Substances of Very High Concern (SVHC) list, due to its suspected carcinogenic properties.

Applications

What are bisphenols used for?

Bisphenols have a variety of applications, but two of the most significant uses of bisphenols are in the production of polycarbonate plastics and epoxy resins.

Polycarbonates

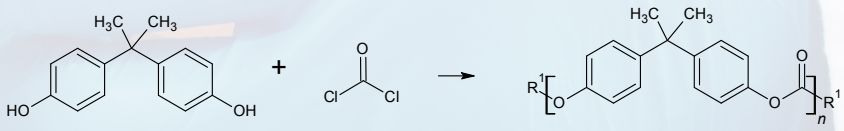
Some types of bisphenol chemicals, like BPA, are used in polycarbonate plastics (PCs), which are high-performance, transparent plastics. Polycarbonate is used to make consumer goods across almost every industry.

Polycarbonate is a tough, hard and transparent thermoplastic. Due to its durability and scratch resistance, it is widely used in the medical and healthcare industry to produce medical equipment and devices such as glass lenses and dental fillings.

Although it is widely compared to polymethyl methacrylates, an engineering plastic used as a shatter-resistant alternative to glass, polycarbonate is stronger and much more durable.

Its increased usage across a wide range of industries, including automotive and transportation, packaging, consumer goods, and healthcare has earned the global polycarbonate market an estimated valuation of USD 21.75 billion in 2022. It is expected to reach USD 32.36 billion by 2030.[11]

Typically, polycarbonate plastics are produced by the reaction of bisphenols, (i.e. BPA, BaP) and phosgene.



General structure of polycarbonates based on BPA

Epoxy resins

Epoxy resins are one of the most useful resins and have been used in products across most industries. Many types of epoxy resins with different properties are used, but the most-commonly applied epoxy resin is made from BPA.

Epoxies are more heat- and chemical-resistant than most glues and can adhere to wood, metal, glass, stone, and some plastics. The primary areas for application of epoxy resins in construction projects are coatings, flooring, concrete restoration, crack repair, and as joint materials for tiles.

The uses of epoxy resins and polycarbonates include:

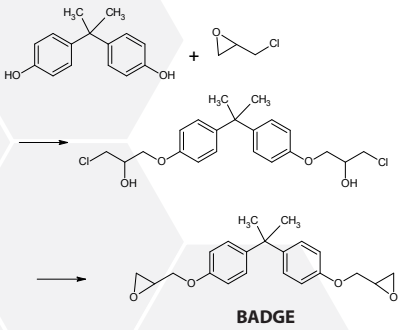
- **Receipt paper**
  Thermal paper, inks, textiles and paper. [4]
- **Food and beverage can liners, plastic water bottles**
  Used to coat the insides of water pipes as well as food and drink cans to increase their shelf-life. [4]
- **Medical equipment and dental materials**
  Filling materials, sealants and orthodontic bonding materials. [5,6]
- **Epoxy resins and polycarbonate plastic materials**
  Reusable plastic tableware and bottles for drinks, sports equipment, CDs and DVDs. [3]

Applications

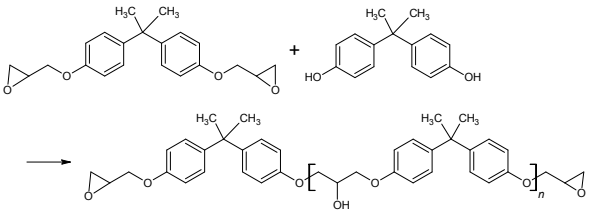
Epoxy resin synthesis

The key reaction to produce epoxy resins is the reaction between bisphenol and epichlorohydrin, a process that was patented in 1946.

When BPA is further cyclized to epoxides, it produces Bisphenol A diglycidyl ether, otherwise known as BADGE. Epoxy resins are then formed by the reaction between BADGE and Bisphenol A.



BADGE



Typical structure of an epoxy resin. Higher molecular weight diglycidyl ethers are formed by the further reaction with bisphenol A.

Cyclo-diBADGE

A concern with both polycarbonates and epoxy resins is the release of BPA and other compounds into food and beverages from the packaging they are stored in.

A common bi-product found in the synthesis of epoxy resins is the cyclized product Cyclo-diBADGE, which forms in amounts between 1-5% during the reaction process.

The presence of Cyclo-diBADGE has caused concern since it was discovered, as there is a possibility it may also be released from the epoxy resins used in cans and contaminating food and beverages.[12]

ECHA

The ECHA published an evaluation of food contact materials, where they raised concern about the presence of Cyclo-diBADGE.[13]

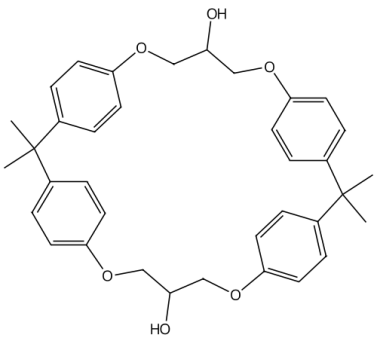
Cyclo-diBADGE

Chiron part: 10586.36

Synonym: Cyclo-diBA

CAS: 20583-87-3

Molecular Weight: 568.70



Plastics in the environment

Microplastics

Polycarbonate is among the 6 most common plastics found in the environment, and one of the most frequently detected when analysing samples for microplastic particles. The commonly found plastics are:

- Polyethylene (PE)
- Polyethylene terephthalate (PET)
- Polystyrene (PS)
- Polypropylene (PP)
- Polyvinyl Chloride (PVC)
- Polycarbonate (PC)

"Prefs®" is the registered trade name name of the microplastic project established in partnership with Innovation Norway.

PRefs will introduce three sub-brands, with each brand specialising in microplastics of different sizes and providing its own respective reference materials.

Chiron is involved in the development and production of analytical microplastic certified reference materials through the EU projects EUROqCHARM (www.euroqcharm.eu), and the MicroPRefs project in partnership with Innovation Norway.

Microplastic reference materials

Available standards are made for pyrolysis GC-MS, and tablets are produced for counting microplastic particles in a sample using MicroFT-IR, FT-RAMAN or similar techniques.

Available polycarbonate standards:

Chiron Part No.	Name	Synonym	CAS	Applications
15251.X-10MG	PC 50-300 micron	PC; Bisphenol A-carbonic acid copolymer	25037-45-0	Standard for pyrolysis GC-MS
15251.X-50/300-TAB	PC 50-300 micron, tablet	PC; Bisphenol A-carbonic acid copolymer	25037-45-0	MicroFTIR or RAMAN analysis. To certify the number of microplastic particles in a sample

For other microplastic standards, contact **sales@chiron.no**

How are bisphenols regulated?

North America

Since 2010, Canadian authorities have banned use of BPA in baby bottles, although government agencies maintain that the chemical does not pose a health risk to humans.[8]

The U.S. Food and Drug Administration (FDA) has banned the use of polycarbonate resins in baby bottles, sippy cups and infant formula packaging, but approves the use of BPA in food containers and other packaging.[10]

The EPA has no current BPA regulations, but it has raised concerns over the environmental and health effects of the chemical.[1]

Europe

The European Commission has also prohibited the use of bisphenols in the manufacture of polycarbonate infant feeding bottles. The European Union (EU) also introduced stricter limits on BPA in food contact materials in 2018.[9]

On 17th January 2023, the ECHA added two new bisphenols to the Candidate List of SVHC:

Bisphenol S (BPS, 4,4'-sulphonyldiphenol, Chiron part: 12534.12)
The flame retardant, 3,3'5,5'-tetrabromobisphenol A (TBBPA, Chiron part: 2674.15)

The reason for inclusion on the list was given as toxic for reproduction and endocrine disrupting properties. They join:

Bisphenol A (BPA, 4,4'-isopropylidenediphenol, Chiron part: 1220.15)
Bisphenol B (BPB, 4,4'-(1-methylpropylidene)bisphenol, Chiron part: 12521.16)
Bisphenol MIBK (2,2-bis(4'-hydroxyphenyl)-4-methylpentane, Chiron part: 14057.18)

This brings the number of bisphenols on the Candidate List of SVHC to a total of five.[14]

The ECHA has also stated there is a need for (further) EU regulatory risk management; restriction for 34 bisphenols that are known or potential endocrine disruptors for the environment or for human health, or that can be identified as toxic for reproduction.[15]

The new and extensive EU project PARC, consisting of 200 partners from 28 countries and a budget of €400 million, will work together in "Partnership for the Assessment of Risk from Chemicals" to address the toxicology risk from potentially hazardous chemicals.[17]

For more information on SVHC Candidate List and associated regulations, see BMF 87.

Scan the QR code to view.

What does Chiron offer?

To address ongoing concerns regarding the health and environmental impacts of bisphenols, Chiron offers a comprehensive range of reference materials for their analysis.

References

1. Environmental Protection Agency. Risk Management for Bisphenol A (BPA) (2022) https://www.epa.gov/assessing-and-managing-chemicals-under-tsca/risk-management-bisphenol-bpa
2. The Guardian. Bisphenol: what to know about the chemicals in water bottles and cans (2019) https://www.theguardian.com/us-news/2019/may/24/bisphenols-bpa-everyday-toxics-guide
3. Science.org. BPA substitutes may be just as bad as the popular consumer plastic (2018) https://www.science.org/content/article/bpa-substitutes-may-be-just-bad-popular-consumer-plastic
4. European Chemicals Agency (ECHA). Bisphenols. https://www.echa.europa.eu/hot-topics/bisphenols
5. National Library of Medicine. Presence and leaching of bisphenol a (BPA) from dental materials (2018) https://www.ncbi.nlm.nih.gov/pmc/articles/PMC5974758/
6. European Commission. The safety of the use of bisphenol A in medical devices (2015) https://ec.europa.eu/health/scientific_committees/emerging/docs/scenihr_o_040.pdf
7. Science.org. In BPA safety war, a battle over evidence (2017) https://www.science.org/content/article/bpa-safety-war-battle-over-evidence
8. Government of Canada. Bisphenol A (BPA) (2020) https://www.canada.ca/en/health-canada/services/home-garden-safety/bisphenol-bpa.html
9. European Food Safety Authority. Bisphenol A (2022) https://www.efsa.europa.eu/en/topics/topic/bisphenol
10. U.S. Food & Drug Administration. Bisphenol A (BPA): Use in Food Contact Application (2014) https://www.fda.gov/food/food-additives-petitions/bisphenol-bpa-use-food-contact-application
11. Polycarbonate Market Size & Share Report, (2022 - 2030) (grandviewresearch.com)
12. Migration of cyclo-di-BADGE into oily foods (2016) | Food Packaging Forum
13. Brussels, 9.6.2022 SWD(2022) 163 final COMMISSION STAFF WORKING DOCUMENT EVALUATION of the legislation on food contact materials - Regulation (EC) No 1935/2004 {SEC(2022) 251 final} - {SWD(2022) 164 final}
14. European Chemicals Agency https://echa.europa.eu/es/-/echa-adds-nine-hazardous-chemicals-to-candidate-list
15. https://echa.europa.eu/es/registry-of-restriction-intentions/-/dislist/details/0b0236e1853413ea
16. Assessment of regulatory needs, ECHA (2021) https://echa.europa.eu/documents/10162/5aa40d13-84e9-6645-c6b8-5fc8616edad8
17. Partnership for the Assessment of Risks from Chemicals | PARC Project | Fact Sheet | HORIZON | CORDIS | European Commission (europa.eu)

Bisphenol product listing

ISO 17034
ISO/IEC 17025
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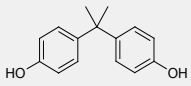
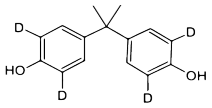
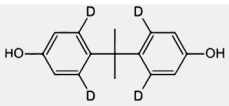
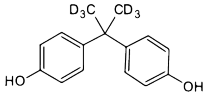
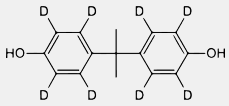
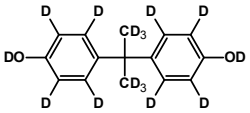
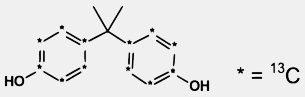
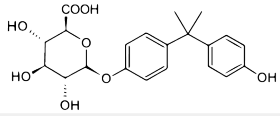
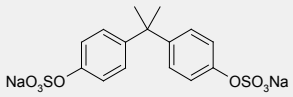
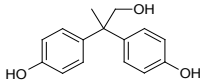
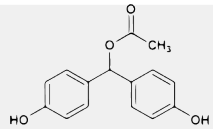
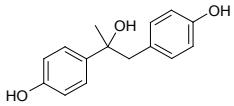
1220.15	Bisphenol A (BPA)		80-05-7
2416.15	Bisphenol A-3,3′,5,5′-d4		347841-41-2
2415.15	Bisphenol A-2,2′,6,6′-d4		102438-62-0
2417.15	Bisphenol A-d6 (dimethyl-d6)		86588-58-1
2418.15	Bisphenol A-2,2′,3,3′,5,5′,6,6′-d8		92739-58-7
2419.15	Bisphenol A-d16		96210-87-6
12513.15	Bisphenol A-13C12		263261-65-0
10572.21	Bisphenol A beta-D-glucuronide		267244-08-6
12558.15	Bisphenol A bisulfate disodium salt 90% chem purity		10040-44-5
12539.14	2,2-Bis(4-hydroxyphenyl)propanol		142648-65-5
15955.15	Methyl bis(4-hydroxyphenyl)acetate		5129-00-0
12541.15	1,2-Bis(4-hydroxyphenyl)-2-hydroxypropane		154928-56-0

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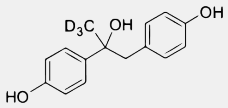
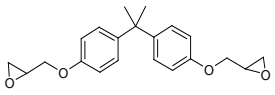
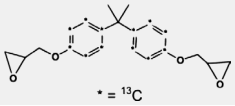
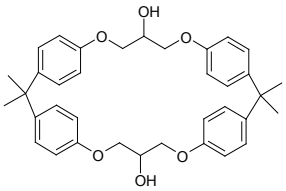
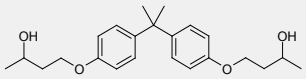
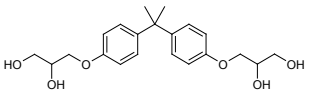
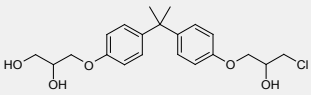
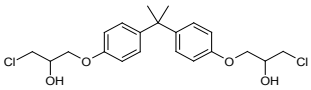
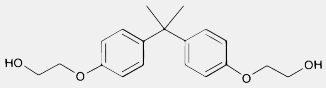
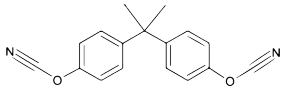
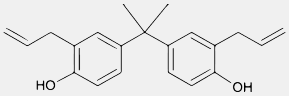
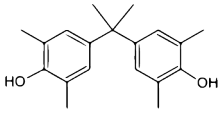
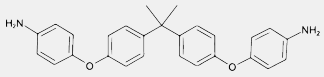
12542.15	1,2-Bis(4-hydroxyphenyl)-2-hydroxypropane-d3		N/A
12514.21	Bisphenol A diglycidyl ether (BADGE)		1675-54-3
12543.21	Bisphenol A diglycidyl ether-13C12 (BADGE-13C12)		1675-54-3 (unlabelled)
10586.36	Cyclo-di-BADGE (Cyclo-diBA)		20583-87-3
10772.23	Bisphenol A bis(2-hydroxypropyl) ether (BPA 2PO)		116-37-0
12515.20	Bisphenol A bis(2,3-dihydroxypropyl) ether (BADGE.2H2O)		5581-32-8
12516.20	Bisphenol A (3-chloro-2 hydroxypropyl) (2,3-dihydroxypropyl) ether		227947-06-0
12517.20	Bisphenol A bis(3-chloro-2-hydroxypropyl) ether (BADGE.2HCl)		4809-35-2
15385.19	Bisphenol A bis(2-hydroxyethyl) (BPA 2EO)		901-44-0
15386.17	Bisphenol A cyanate ester (BADCy)		1156-51-0
15387.21	o,o'-Diallylbisphenol A (DAB; DABPA)		1745-89-7
15388.19	3,3',5,5'-Tetramethylbisphenol A (TMBPA)		5613-46-7
15389.27	Bisphenol A bis(4-aminophenyl) ether (BAPP)		13080-86-9

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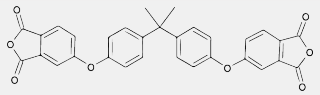
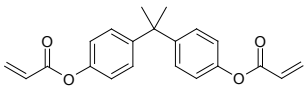
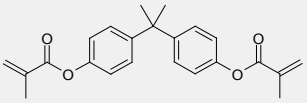
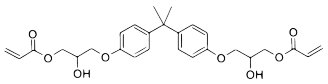
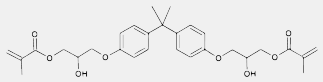
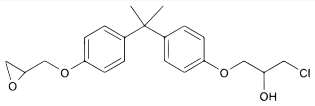
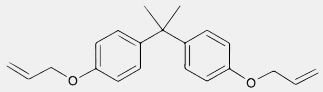
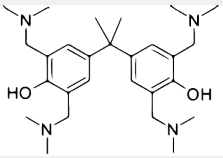
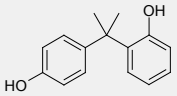
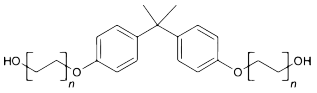
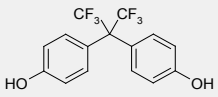
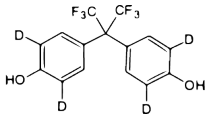
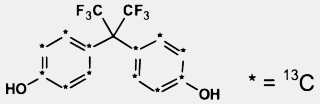
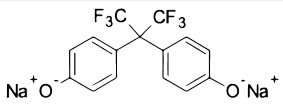
Chiron No	Name (synonym)	Structure	CAS
15390.31	Bisphenol A diphthalic anhydride (BPA-DA; BISDA)		38103-06-9
12552.21	Bisphenol A diacrylate (BPADA)		4491-03-6
12553.23	Bisphenol A dimethacrylate (BPADMA)		3253-39-2
12554.27	Bisphenol A diglycidyl ether diacrylate; (BADGE dimethacrylate; BGDMA; Bisphenol A glycidyl acrylate)		4687-94-9
12555.29	Bisphenol A diglycidyl ether dimethacrylate (BADGE dimethacrylate; BGDMA; Bisphenol A glycidyl methacrylate; Bis-GMA)		1565-94-2
14605.21	Bisphenol A (3-chloro-2-hydroxypropyl)glycidyl ether		13836-48-1
15394.21	Bisphenol A diallyl ether (BPA-AE; O,O-Diallylbisphenol A)		3739-67-1
15396.27	Tetrakis(dimethylaminomethyl)bisphenol A		16224-36-5
12518.15	2,4'-Bisphenol A (24-Bisphenol A)		837-08-1
14399.27	Bisphenol A ethoxylated (6 moles EO/Bisphenol)		32492-61-8
12519.15	Bisphenol AF		1478-61-1
12544.15	Bisphenol AF-d4 (3,3'5,5'-d4)		1478-61-1 (unlabelled)
12545.15	Bisphenol AF-13C12		2411504-31-7
15405.15	Bisphenol AF disodium salt (T-6627)		74938-83-3

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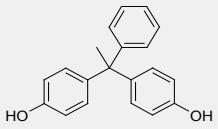
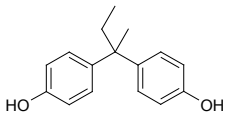
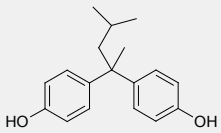
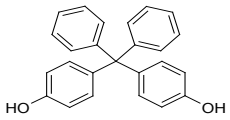
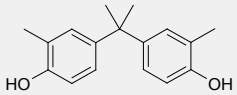
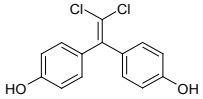
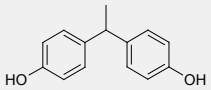
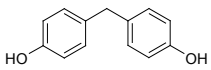
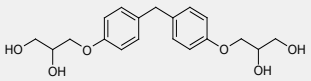
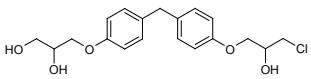
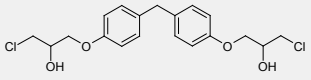
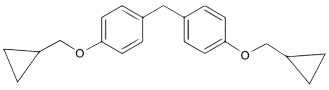
12520.20	Bisphenol AP		1571-75-1
12521.16	Bisphenol B		77-40-7
14057.18	Bis MIBK; BisP-MIKB; NSC 73727 2,2-Bis(4'-hydroxyphenyl)-4-methylpentane		6807-17-6
12522.25	Bisphenol BP (BisP-BP)		1844-01-5
12523.25	Bisphenol C (BPC)		79-97-0
12514.14	Bisphenol C 2 (1,1-Dichloro-2,2-bis(4-hydroxyphenyl)ethylene)		14868-03-2
12525.14	Bisphenol E (BPE)		2081-08-5
12526.13	Bisphenol F (BPF)		620-92-8
12527.19	Bisphenol F bis(2,3-dihydroxypropyl) ether (BFDGE.2H2O)		72406-26-9
12528.19	Bisphenol F (3-Choro-2-hydroxypropyl)(2,3-dihydroxypropyl) ether		235741-58-9
12529.20	Bisphenol F bis(3-chloro-2-hydroxypropyl) ether (BFDGE.2HCl)		235741-59-0
15414.19	Bisphenol F diglycidyl ether (p,p-BFDGE)		2095-03-6

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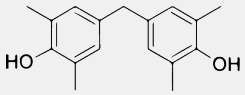
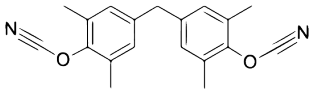
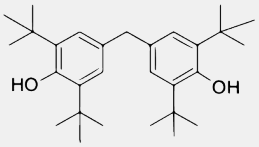
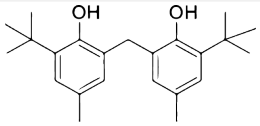
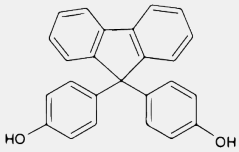
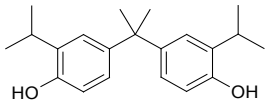
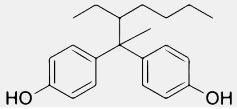
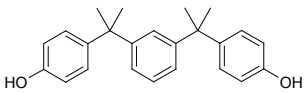
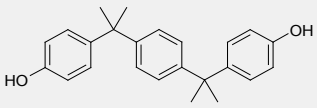
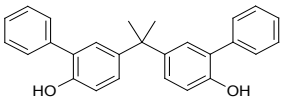
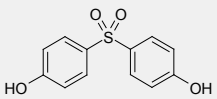
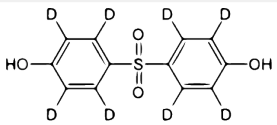
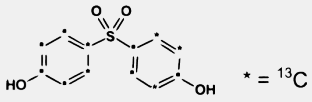
15415.17	Bisphenol F 3,5,3′,5′-tetramethyl (TMBPF; Tetramethyl Bisphenol F)		5384-21-4
15416.19	Bisphenol F 3,5,3′,5′-tetramethyl dicyanate (TMBPFCy)		101657-77-6
15418.29	Bisphenol F 3,5,3′,5′-tetra-tert-butyl (TBMD)		118-82-1
15044.23	2,2′-Methylenebis[4-methyl-6-tert-butylphenol] (DBMC)		119-47-1
15402.25	Bisphenol FL (BPFL; BPF)		3236-71-3
12531.21	Bisphenol G (Bis-OIPP-A)		127-54-8
15412.20	Bisphenol IOTD (BisP-IOTD)		74462-02-5
12532.24	Bisphenol M		13595-25-0
13739.24	Bisphenol P		2167-51-3
12546.27	Bisphenol PH (BisOPP-A)		24038-68-4
12534.12	Bisphenol S (BPS 1)		80-09-1
12547.12	Bisphenol S-d8 (2,2′,3,3′,5,5′,6,6′-d8)		2483831-28-1
12538.12	Bisphenol S-13C12		1991267-29-8

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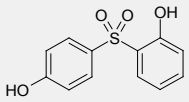
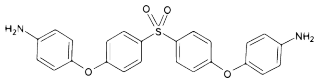
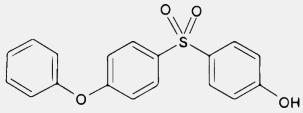
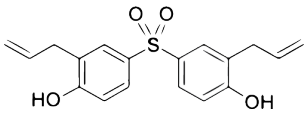
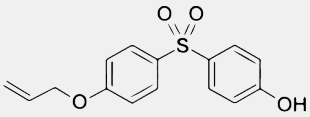
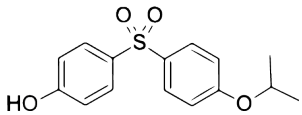
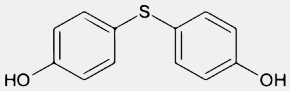
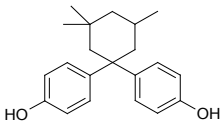
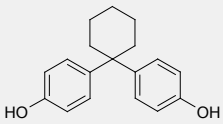
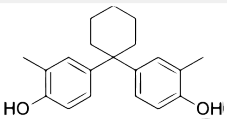
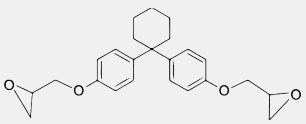
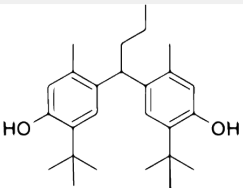
12535.12	2,4′-Bisphenol S (24-Bisphenol S)		5397-34-2
15397.24	Bis(4-aminophenyl)bisphenol S (BAPS; SED)		13080-89-2
15398.19	Bisphenol S 4-benzyl ether (BPS-MPE; BPS-BN)		63134-33-8
15400.18	Bisphenol S 2,2′-diallyl (TG-SA, TG-SH, TGSH)		41481-66-7
15401.15	Bisphenol S 4-allyl ether (BPS-MAE; BIS-MAE)		97042-18-7
14403.15	Bisphenol S 4-isopropyl ether (D8, D8 (sulfone), D-8 DEVELOPER; D8(HPS); 4-hydroxy-4′-iso-propoxydip; BPS-IP))		95235-30-6
15887.12	4,4′-Thiodiphenol (Bisphenol T)		2664-63-3
12536.21	Bisphenol TMC (BisP-TMC)		129188-99-4
12537.18	Bisphenol Z (Bis-Z)		843-55-0
15403.20	Bisphenol CZ; Bisphenol Z 3,3′dimethyl (BPOCTMC)		2362-14-3
15404.24	Bisphenol Z diglycidyl ether (BZDGE)		13446-84-9
15406.26	6,6′-Di-tert-butyl-4,4′-butylidenedi-m-cresol (BBM)		85-60-9

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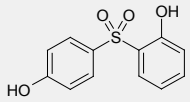
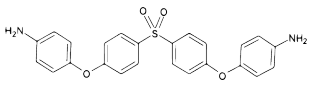
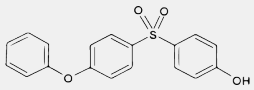
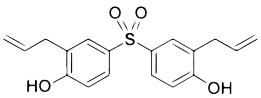
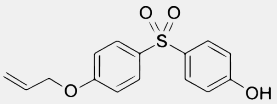
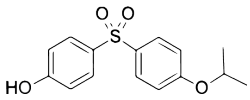
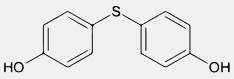
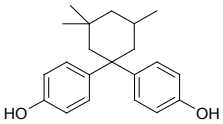
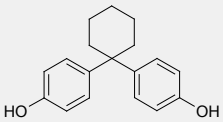
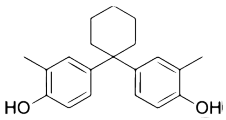
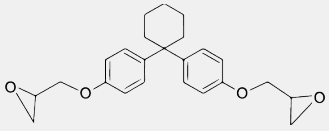
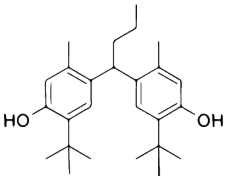
12535.12	2,4′-Bisphenol S (24-Bisphenol S)		5397-34-2
15397.24	Bis(4-aminophenyl)bisphenol S (BAPS; SED)		13080-89-2
15398.19	Bisphenol S 4-benzyl ether (BPS-MPE; BPS-BN)		63134-33-8
15400.18	Bisphenol S 2,2′-diallyl (TG-SA, TG-SH, TGSH)		41481-66-7
15401.15	Bisphenol S 4-allyl ether (BPS-MAE; BIS-MAE)		97042-18-7
14403.15	Bisphenol S 4-isopropyl ether (D8, D8 (sulfone), D-8 DEVELOPER; D8(HPS); 4-hydroxy-4′-iso-propoxydip; BPS-IP))		95235-30-6
15887.12	4,4′-Thiodiphenol (Bisphenol T)		2664-63-3
12536.21	Bisphenol TMC (BisP-TMC)		129188-99-4
12537.18	Bisphenol Z (Bis-Z)		843-55-0
15403.20	Bisphenol CZ; Bisphenol Z 3,3′dimethyl (BPOCTMC)		2362-14-3
15404.24	Bisphenol Z diglycidyl ether (BZDGE)		13446-84-9
15406.26	6,6′-Di-tert-butyl-4,4′-butylidenedi-m-cresol (BBM)		85-60-9

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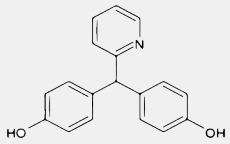
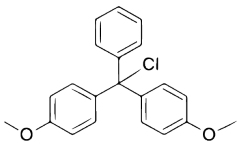
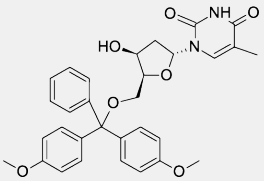
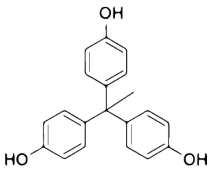
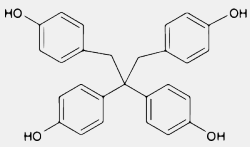
15407.18	p,p′-(2-Pyridylmethylene)bisphenol (DDPM)		603-41-8
15408.21	4,4′-Dimethoxytritylchloride (DMTrC)		40615-36-9
15409.31	5′-O-(p,p′-Dimethoxytrityl)thymidine		40615-39-2
15410.20	Tris(4-hydroxyphenyl)ethane (DMTrC)		27955-94-8
15411.25	4,4′,4″,4‴-Methanetetrayltetraphenol Tetra(p-hydroxyphenyl)methane		53184-78-4

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Bisphenol similar compounds

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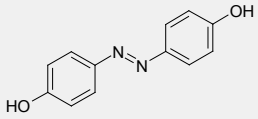
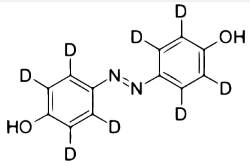
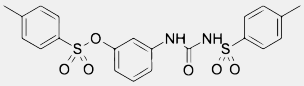
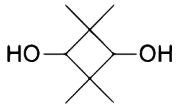
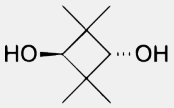
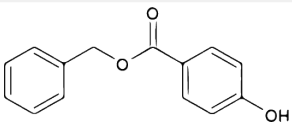
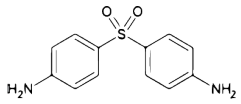
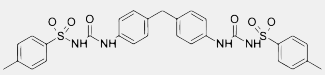
12511.12	trans-4,4′-Azadiphenol		51437-66-2
12512.12	trans-4,4′-Azadiphenol-d8		N/A
15858.21	3-(3-Tosylureido)phenyl 4-methylbenzenesulfonate (Pergafast® 201)		232938-43-1
15856.8	2,2,4,4-Tetramethyl-1,3-cyclobutanediol		3010-96-6
15857.8	(1R,3R)-2,2,4,4-Tetramethyl-1,3-cyclobutanediol (trans)		2694-23-7
10211.14	Benzyl 4-hydroxybenzoate (Benzylparaben)		94-18-8
15956.42	Phenol, reaction products with 4,4′-sulfonylbis[benzenamine] and 2,4-TDI (Urea-urethane Compound)	N/A	321860-75-7
8499.12	Bis(4-aminophenyl) sulfone (Dapsone)		80-08-0
15888.29	4,4′-Bis(p-toluenesulfonyl-aminocarbonylamino)diphenylmethane (BTUM)		151882-81-4

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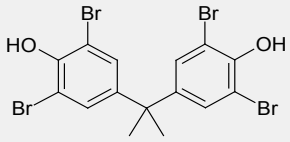
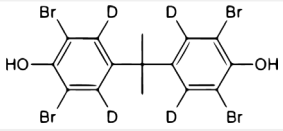
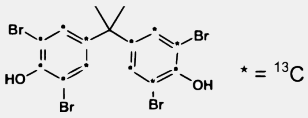
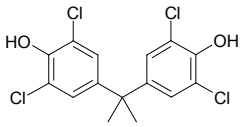
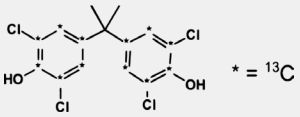
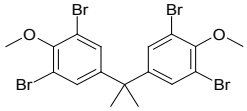
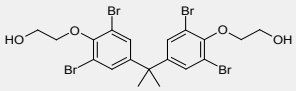
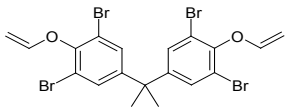
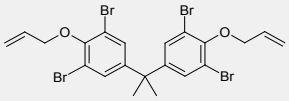
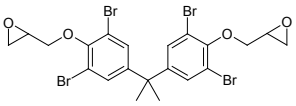
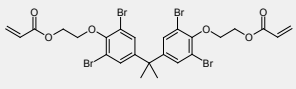
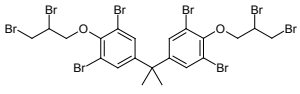
Brominated and chlorinated bisphenols (Flame retardants):

Chiron No	Name (synonym)	Structure	CAS
2674.15	3,3′,5,5′-Tetrabromobisphenol A (TBBPA)		79-94-7
12548.12	3,3′,5,5′-Tetrabromobisphenol A-d4 (2,2′,6,6′-d4) (TBBPA-d4)		N/A
12549.12	3,3′,5,5′-Tetrabromobisphenol A-13C12 (TBBPA-13C12)		1352876-39-1
12550.12	3,3′,5,5′-Tetrachlorobisphenol A (TCBPA)		79-95-8
12551.12	3,3′,5,5′-Tetrachlorobisphenol A-13C12 (TCBPA-13C12)		N/A
2675.17	3,3′,5,5′-Tetrabromobisphenol A dimethyl ether (TBBPA-BME)		37853-61-5
8772.19	3,3′,5,5′-Tetrabromobisphenol A bis(2-hydroxyethyl) ether (TBBPA-BHEE)		4162-45-2
8887.21	3,3′,5,5′-Tetrabromobisphenol A diallyl ether (TBBPA-BAE)		25327-89-3
11116.2	3,3′,5,5′-Tetrabromobisphenol A bisacrylate (TBPPA-BA)		55205-38-4
10589.21	3,3′,5,5′-Tetrabromobisphenol A diglycidyl ether (BDBPT; Tetrabromobisphenol A Bis(2,3-dibromopropyl) ether) (TBBPA-BGE)		3072-84-2
11117.25	3,3′,5,5′-Tetrabromobisphenol A bis(2-hydroxyethyl) ether bisacrylate (TBBPA-BHEEBA)		66710-97-2
8751.21	2,2-Bis[3,5-dibromo-4-(2,3-dibromopropoxy)phenyl]propane, purified (BDBPT; Tetrabromobisphenol A Bis(2,3-dibromopropyl) ether)		21850-44-2

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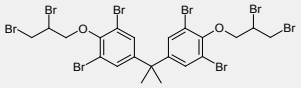
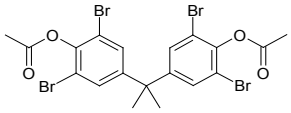
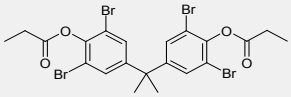
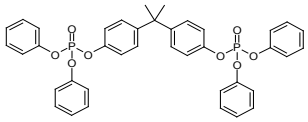
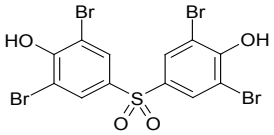
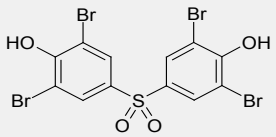
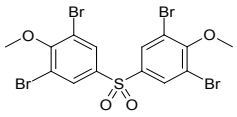
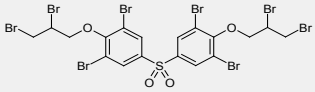
10454.21	2,2-Bis[3,5-dibromo-4-(2,3-dibromopropoxy)phenyl]propane, techn. (BDBPT; Tetrabromobisphenol A Bis(2,3-dibromopropyl) ether)		21850-44-2
11118.19	3,3′,5,5′-Tetrabromobisphenol A diacetate (TBBPA-BOAc)		33798-02-6
11119.21	3,3′,5,5′-Tetrabromobisphenol A bispropionate (TBBPA-BP)		37419-42-4
8768.X	2,4,6-Tribromophenylterminated tetrabromobisphenol-A carbonate oligomer	3 components	71342-77-3
8767.22	Phenoxyterminated carbonate oligomer of tetrabromobisphenol A	3 components	94334-64-2
10084.39	Bisphenol A bis(diphenyl) phosphate, 99% (BPA-BDPP; BDP)		5945-33-5
8756.39	Bisphenol A bis(diphenyl) phosphate, techn. (BPA-BDPP; BDP, techn.)	See structure above	5945-33-5 / 181028-79-5 (techn.)
10481.12	3,3′,5,5′-Tetrabromobisphenol S, 98% (TBBPS; 4,4′-Sulfonylbis(2,6-dibromophenol))		39635-79-5
10457.12	3,3′,5,5′-Tetrabromobisphenol S, techn. (TBBPS; 4,4′-Sulfonylbis(2,6-dibromophenol))		39635-79-5
10590.14	3,3′,5,5′-Tetrabromobisphenol S dimethyl ether (TBBPS-BME)		70156-79-5
10451.18	3,3′,5,5′-Tetrabromobisphenol S bis(2,3-dibromopropyl ether) (TBBPS-BDBPE)		42757-55-1

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