

European Semiconductor Industry Association (ESIA) submission to possible additional RoHS substances study, March 2008.

Table I: Hazardous substances in EEE – high priority

Please find information which ESIA put together in time allowed for the consultation. All comments refer to uses in the semiconductor industry sector.

ID	Substance name	CAS-Nr.	Hazard	Main use in EEE	Stakeholder Input		
					Specification of use: component(s) in which substance is contained	Quantity	General comments
1	Antimony trioxide	1309-64-4	Carc Cat. 3 R40	Synergist brominated flame retardants;	Substance used in the flame retardant system in Semiconductor packaging. In moulding compound, of semiconductor products. Used in all package platforms. Essential substance in the flame retardant system		Sb ₂ O ₃ must be used with most types of brominated flame retardants. There are no substitutes that are as effective. Only brominated flame retardants are suitable for some types of plastic ¹ . No suitable alternative available – needed indefinitely
2	Antimony compounds	-	Xn; R20/22 N; R51-53	Flame retardant; melting agent in CRT glass; solder material (antimony-tin) Melting agent in CRT glass	Contained in solder, including Pb-free solders. Used as a dopant in Semiconductor die – metallic, not compound Semiconductor die attach – attaches silicon circuit to		No suitable alternative available – needed indefinitely

¹ Danish EPA study – see table 2.2 <http://www2.mst.dk/Udgiv/publications/2007/978-87-7052-351-6/pdf/978-87-7052-352-3.pdf>

ID	Substance name	CAS-Nr.	Hazard	Main use in EEE	Stakeholder Input		
					Specification of use: component(s) in which substance is contained	Quantity	General comments
					substrate In molding compounds for SC packaging Brightener in some plating systems.		
3	Arsenic/arsenic compounds	7440-38-2	T; R23/25 N; R50-53	III-V group semiconductor substrate (GaAs) Flame retardant	Arsenic is used as a dopant during the manufacturing process of Semiconductors (fundamental element of semiconductors and whole electronics chain) See attached ESIA technical paper on arsenic and arsenic compounds for further details		(See 14 GaAs)Arsenic compounds based semiconductors are used because of their unique combinations of characteristics and properties. There are no alternatives for most applications. (fundamental element of semiconductors and whole electronics chain) See attached ESIA technical paper on arsenic and arsenic compounds for further details No suitable alternative available – needed indefinitely
4	Beryllium metal	7440-41-7	Carc. Cat. 2; R49 T+; R26 T; R25-48/23 Xi; R36/37/38 R43	In alloys; copper-beryllium alloy; Connectors: contact springs, improves elasticity of copper alloy; Finger clips PCs: maintains electrical conductivity in metal housing; Monitors Relays: improves properties of copper contact springs Switches: high strength, high	Gold wire Most test and burn-in sockets use BeCu.		No suitable alternative – needed indefinitely for all these applications

ID	Substance name	CAS-Nr.	Hazard	Main use in EEE	Stakeholder Input		
					Specification of use: component(s) in which substance is contained	Quantity	General comments
				conductivity Laser printers: Rotating mirror, lightweight rigidity for precision instrumentation			
5	Beryllium oxide BeO	1304-56-9	Carc. Cat. 2; R49 T+; R26 T; R25-48/23 Xi; R36/37/38 R43	In ceramics, as cooling device; Thermally conductive electrical insulator	BeO is used in high power modules as a substrate material. The material is lightweight, very rigid, withstands extreme temperatures and rapidly dissipates heat better than any other ceramic material. BeO is used in heat producing circuits . This unique material is needed for critical components that require superior performance at high temperatures. Specialty substrates.		BeO has the highest thermal conductivity of any electrically insulating material. Its thermal conductivity is similar to that of copper and so is used as an insulator on high power semiconductors to conduct heat away from the device. The next best material is aluminium nitride which has a thermal conductivity only one half that of BeO. BeO is expensive and so is used only if there are no alternatives. Parts containing BeO should be marked with a warning that it is present. No suitable alternative – needed indefinitely for all these applications
6	Tetrabromo bisphenol A and related compounds (see Table II)	79-94-7	Dangerous to the environment N; R50/53	Flame retardant	Brominated epoxy in molding compounds for semiconductor products.		The brominated epoxy reacts with the other polymers resulting in one cross linked system. Used in production of many semiconductor mold compounds

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							and substrates that contain FR4, but is not present in the final product.
7	Bisphenol A (4,4'-Isopropylidendiphenol)	80-05-7	Repr. Cat. 3; R62 Xi; R37-41 R43	Polycarbonate plastic in electronic devices, medical equipment; in PVC as hardener, catalyst, binding agents, stabiliser; epoxy resin production	All Epoxy materials with BPA as hardener All Packge platforms effected		Epoxidized Bis A used in molding compounds and die attach epoxies. <u>Not used as a phenol. – not contained in most final products;</u> No suitable alternative – needed indefinitely for all these applications
8	Diethylhexylphthalate (DEHP)	117-81-7	Repr. Cat. 2; R60-61	Plasticizer in PVC cables	May be used in tape and film adhesives; used in cables.		No suitable alternative – needed indefinitely for all these applications
9	Butylbenzylphthalate (BBP)	85-68-7	Repr. Cat.2; R61 Repr. Cat.3; R62 N; R50-53	Plasticizer in PVC cables	May be used in tape and film adhesives		
10	Dibutylphthalate (DBP)	84-74-2	Repr. Cat. 2; R61 Repr. Cat. 3; R62 N; R50	Plasticizer in PVC cables	May be used in tape and film adhesives		
11	Diocetylphthalate (DOP)	117-84-0	Dangerous to the Environment	Plasticizer in PVC cables	May be used in tape and film adhesives		
12	Dimethylformamide (DMF)	68-12-2	Repr. Cat. 2; R61 Xn; R20/21 Xi; R36	Electrolyte capacitors			
13	Formaldehyde	50-00-0	Carc. Cat. 3; R40 T; R23/24/25	Monomer (e.g. phenol resin and melamine resin)	Molding compounds, die attach epoxy		Phenol formaldehyde resins used as curing agents in epoxy molding compounds and die

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			C; R34 ,R43		precursor.		attach. Formaldehyde may be part of suppliers synthesis route. <u>Not in final product</u>
14	Gallium arsenide	1303-00-0	Human carcinogen*	Power amplifiers, semiconductors for communication electronics	Ga-As is used as substrate material with superior properties to manufacture GaAs transistors.		GaAs semiconductor uses less power, is less susceptible to heat and is much faster than silicon. It is therefore used for very high frequency ICs and other devices. GaAs is however difficult to make and so much more expensive than silicon. As a result it is always used <u>only</u> if there is no alternative. No suitable alternative – needed indefinitely for all these applications Reference: ESIA GaAs Paper
15	Hexabromocyclododecane (HBCDD) and further brominated flame retardants (see table II)	3194-55-6	not (yet) classified in the Annex I of Directive 67/548/EEC; proposal: R33, R64, N R50-53; PBT	Flame retardant	Used in specific applications in mold compounds		No suitable alternative – needed indefinitely for these specific applications
16	Liquid crystals e.g. MBBA (4-methoxybenzylidene-4-butylaniline); 5CB (4-pentyl-4-cyanobiphenyl)			Electroactive layer in liquid crystal displays of cellular phones, notebooks, PC monitors			
17	Medium-chained chlorinated paraffins	85535-85-9		secondary plasticisers in PVC (cable) flame retardant			

ID	Substance name	CAS-Nr.	Hazard	Main use in EEE	Stakeholder Input		
					Specification of use: component(s) in which substance is contained	Quantity	General comments
	(MCCP) (Alkanes, C14-17, chloro)			plasticisers in rubbers			
18	Nickel ²	7440-02-0	Carc. Cat. 3; R40 R43	Stainless steel, plating; Decorative metal finishes, barrier layers	Surface finish on lead frames, substrates, heat sinks and some solder materials. Bumps and array substrates. Barrier layer for leadframes, substrates, Used as Ni anodes, Ni salts such as Ni sulphate and Ni sulfamate.		No suitable alternative – needed indefinitely for these specific applications Used in lead free applications as an alternative material. There is no possible skin contact
19	Nonylphenol Nonylphenolpolyglycol ethers (Nonylphenoxyethoxylates)	25154-52-3 9016-45-9	Repr.Cat.3; R62 Repr.Cat.3; R63 Xn; R22 C; R34 N; R50-53	Surfactants, antioxidant in plastics			
20	Perfluorooctane sulfonates ³	1763-23-1	-				Already regulated in the EU by Directive 76/769 EEC PFOS is not contained in final SC product
21	PVC	9002-86-2	Dependent on the additives	Sleeve material (of capacitors), cables, tubing films labels and gaskets, insulator, chemical	PVC is used as b2b packing material (tubes).		PVC itself is not hazardous. The combination of properties are very difficult to duplicate with

² Only in those applications where nickel is likely to result in direct and prolonged skin exposure

³ Restriction does not apply to the following applications or processes: 1) photoresists or antireflective coatings for photolithography processes; 2) photographic coatings applied to films, papers, or printing plates; 3) mist suppressants for non-decorative hard chromium (VI) plating; 4) wetting agents for use in controlled electroplating systems

ID	Substance name	CAS-Nr.	Hazard	Main use in EEE	Stakeholder Input		
					Specification of use: component(s) in which substance is contained	Quantity	General comments
			(stabilizers and plasticizer) used; Dioxin formation during incineration; Source of organic bound chlorine	resistance, transparency, sheath material	RFID		alternative plastics for some applications. Semiconductors support world wide collection and recycling of the tube material. Not present in final product
22	PCBs Polychlorinated Biphenyls	1336-36-3 and various others	R33 N; R50-53 Dioxin/furan formation during incineration	Flame retardant in PVC plastic cable; capacitors			
23	PCT Polychlorinated Terphenyls	61788-33-8 and various others		Electrical insulation medium, Plasticizers, fire retardants, coatings for electrical wire and cable, dielectric sealants			
24	Polychlorinated Naphthalenes	70776-03-3		lubricant, paint, stabilizer (electric characteristic, flame-resistant, water-resistant) insulator, flame retardant			
25	Selenium	7782-49-2	T; R23/25 R33 R53 Toxic/ Danger of cumulative effects / Environment**	Rectifiers and detector instruments, photoreceptor, semiconductor material, light receiving element, photocell	Used in semiconductors such as infrared detectors (category 9). Ag plating brightener		No suitable alternative – needed indefinitely for these specific applications
26	Short-chained chlorinated paraffins (SCCP) (Alkanes, C10-13, chloro)	85535-84-8	Carc. Cat. 3; R40 N; R50-53	plasticisers in PVC (cable) flame retardant plasticisers	May be used in RFID applications		

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27	Synthetic vitreous fibres -glass fibres - mineral wool - refractory ceramic fibre (RCFs)	142844-00-6	RCF: Carc. Cat. 2;	Thermal insulation materials in domestic electrical appliances Used in PCBs	Filler for laminated substrates/ PCB Used to tailor CTE in substrates		No suitable alternative – needed indefinitely for these specific applications
28	Tributyl Tin (TBT) compounds Triphenyl Tin (TPT) compounds	various	T; R25-48/23/25 Xn; R21 Xi; R36/38 N; R50-53; T; R23/24/25 N; R50-53	Stabilizer, antioxidant, antibacterial and antifungal agents, antifoulant, antiseptic, anti-fungal agent, paint, pigment, antistaining			
29	Tributyl Tin Oxide (TBTO)	56-35-9	No classification according to 67/548	antiseptic, antifungal agent, paint, pigment, antistaining, refrigerant, foaming agent, extinguishant,			
30	dinickel trioxide	1314-06-3	Carc. Cat. 1; R49 R43 R53	May be used as an electrolyte			
31	diarsenic trioxide; arsenic trioxide	1327-53-3	Carc. Cat. 1; R45 T+; R28 C; 34 N; R50-53	May be used in certain glass-materials, less than 5000ppm			
32	4,4'-methylenedi-o-toluidine	838-88-0	Carc. Cat. 2; R45 Xn; R22 R43 N; R50-53	Potential use as a dye			
33	Petrolatum; Petrolatum	8009-03-8	Carc. Cat. 2; R45	Used in solder fluxes/pastes			No suitable alternative – needed indefinitely for these specific applications
34	nickel dihydroxide	12054-48-7	Carc. Cat. 3; R40 Xn; R20/22	May be present in certain plastics, metallic- or ceramic	May be used in cables		

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			R43 N; R50-53	materials			
35	tributyl phosphate	126-73-8	Carc.Cat.3; R40 Xn; R22 Xi; R38	May be present in certain plastics, metallic- or ceramic materials	May be used in cables		
36	divanadium pentaoxide; vanadium pentoxide	1314-62-1	Muta. Cat. 3; R68 Repr. Cat. 3; R63 T; R48/23 Xn; R20/22 Xi; R37 N; R51-53	May be present in certain plastics, metallic- or ceramic materials	May be used in cables Some epoxy compounds		
37	nickel sulphate	7786-81-4	Carc. Cat. 3; R40 Xn; R22 R42/43 N; R50-53	May be present in certain plastics, metallic- or ceramic materials	Present in nickel plating baths		Is not contained in final SC product
38	cobalt oxide	1307-96-6	Xn; R22 R43 N; R50-53	May be present in certain plastics, metallic- or ceramic materials			
39	cobalt	7440-48-4	R42/43 R53	May be present in certain plastics, metallic- or ceramic materials	Leadframe plating alloy for some semiconductor components Cobalt Silicide (CoSi2) layers deposition in FE manufacturing		Metal used in special alloys and in electroplated coatings such as NiFeCo which is a substitute for chromium plating that avoids the need to use carcinogenic hexavalent chromium. No suitable alternative – needed indefinitely for these specific applications Essential material used for all advanced SC technologies : 90nm & 120nm
40	2-ethylhexyl acrylate	103-11-7	Xi; R37/38 R43	2-Ethylhexyl acrylate is used as a monomer in the chemical industry for the production of polymers and copolymers, which	cables		

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				are mainly processed further to aqueous polymer dispersions. The polymers and polymer dispersions are used in adhesives and as binders for paints. Other applications include coatings raw materials and uses in the plastics and textiles industries.			
41	Naphthenic acids, copper salts; copper naphthenate	1338-02-9	R10 Xn; R22 N; R50-53	May be present in certain plastics, metallic- or ceramic materials	cables		
42	phenyl bis(2,4,6-trimethylbenzoyl)-phosphine oxide	162881-26-7	R43 R53	May be present in certain plastics, metallic- or ceramic materials	cables		
43	thallium	7440-28-0	T+; R26/28 R33 R53	May be present in certain plastics, metallic- or ceramic materials	Contained in AU plating solutions		No suitable alternative – needed indefinitely for these specific applications
44	bromobenzylbromotoluene mixture of isomers	99688-47-8	Xn; R48/22 R43 N; R50-53	May be present in certain plastics, metallic- or ceramic materials			
45	2,2'-(ethylenedioxy)diethyl diacrylate; triethylene glycol diacrylate	1680-21-3	Xi; R36/38 R43	May be used in carton materials			
46	Rosin; colophony [1]	8050-09-7 [1] 8052-10-6 [2] 73138-82-6 [3]	R43	Used in solder fluxes/pastes	Used in water white rosin fluxes for solderability testing (JEDEC standard) rosin residues can be found in semiconductor packages.		In flux there is often rosin, so package where flux is used rosin residues can be found. No suitable alternative – needed indefinitely for these specific applications

Table II: Brominated flame retardants (other than PBBs or PBDEs) (JIG, 2007)

Brominated Flame Retardants (other than PBBs or PBDEs)	CAS Numbers
Brominated flame retardant which comes under notation of ISO 1043-4 code number FR(14) [Aliphatic/alicyclic brominated compounds]	-
Brominated flame retardant which comes under notation of ISO 1043-4 code number FR(15) [Aliphatic/alicyclic brominated compounds in combination with antimony compounds]	-
Brominated flame retardant which comes under notation of ISO 1043-4 code number FR(16) [Aromatic brominated compounds excluding brominated diphenyl ether and biphenyls]	-
Brominated flame retardant which comes under notation of ISO 1043-4 code number FR(17) [Aromatic brominated compounds excluding brominated diphenyl ether and biphenyls] in combination with antimony compounds]	-
Brominated flame retardant which comes under notation of ISO 1043-4 code number FR(22) [Aliphatic/alicyclic chlorinated and brominated compounds]	-
Brominated flame retardant which comes under notation of ISO 1043-4 code number FR(42) [Brominated organic phosphorus compounds]	-
Poly(2,6-dibromo-phenylene oxide)	69882-11-7
Tetra-decabromo-diphenoxy-benzene	58965-66-5
1,2-Bis(2,4,6-tribromo-phenoxy) ethane	37853-59-1
3,5,3',5'-Tetrabromo-bisphenol A (TBBA)	79-94-7
TBBA, unspecified	30496-13-0
TBBA-epichlorhydrin oligomer	40039-93-8
TBBA-TBBA-diglycidyl-ether oligomer	70682-74-5
TBBA carbonate oligomer	28906-13-0
TBBA carbonate oligomer, phenoxy end capped	94334-64-2
TBBA carbonate oligomer, 2,4,6-tribromo-phenol terminated	71342-77-3
TBBA-bisphenol A-phosgene polymer	32844-27-2
Brominated epoxy resin end-capped with tribromophenol	139638-58-7
Brominated epoxy resin end-capped with tribromophenol	135229-48-0
TBBA-(2,3-dibromo-propyl-ether)	21850-44-2
TBBA bis-(2-hydroxy-ethyl-ether)	4162-45-2
TBBA-bis-(allyl-ether)	25327-89-3
TBBA-dimethyl-ether	37853-61-5
Tetrabromo-bisphenol S	39635-79-5
TBBS-bis-(2,3-dibromo-propyl-ether)	42757-55-1
2,4-Dibromo-phenol	615-58-7
2,4,6-tribromo-phenol	118-79-6
Pentabromo-phenol	608-71-9
2,4,6-Tribromo-phenyl-allyl-ether	3278-89-5
Tribromo-phenyl-allyl-ether, unspecified	26762-91-4
Bis(methyl)tetrabromo-phtalate	55481-60-2
Bis(2-ethylhexyl)tetrabromo-phtalate	26040-51-7
2-Hydroxy-propyl-2-(2-hydroxy-ethoxy)-ethyl-TBP	20566-35-2
TBPA, glycol-and propylene-oxide esters	75790-69-1
N,N'-Ethylene -bis-(tetrabromo-phthalimide)	32588-76-4
Ethylene-bis(5,6-dibromo-norbornane-2,3-dicarboximide)	52907-07-0
2,3-Dibromo-2-butene-1,4-diol	3234-02-4
Dibromo-neopentyl-glycol	3296-90-0
Dibromo-propanol	96-13-9
Tribromo-neopentyl-alcohol	36483-57-5
Poly tribromo-styrene	57137-10-7
Tribromo-styrene	61368-34-1

Table III: Hazardous substances in EEE already regulated by existing legislation

Substance name	CAS-Nr.	Main use in EEE	Hazard	Key Legal and Regulatory Information
Asbestos	12001-28-4 132207-32-0 12172-73-5 77536-66-4 77536-68-6 77536-67-5 12001-29-5	Brake lining pad, insulator, filler, abrasive, insulator, filler, pigment, paint, talc, adiabatic material	Carc. Cat. 1; R45 T; R48/23	76/769/EEC, Marketing and Use of Dangerous Substances and amendments: (83/478/EEC; 85/610/EEC; 87/217/EEC; 91/659/EEC; 99/77/EEC)
Specific Azocolourants and azodyes (which form certain aromatic amines)	Various	Pigment, dyes, colorants		76/769/EEC, Marketing and Use of Dangerous Substances and amendments: (2002/61/EC; 2003/03/EEC).
Ozone Depleting Substances and Hydrochlorofluorocarbons	Various	Refrigerant, foaming agent, insulation extinguishant		Regulation (EC) No. 2037/2000 on substances that deplete the ozone layer