The Constituents of Semiconductor Components

Responsible electronic component and equipment manufacturers are already preparing for the time when the lifespan of their products comes to an end by scrutinizing the materials incorporated and their future recyclability. Recycling laws have already come into force in Germany ("Kreislauf-Wirtschafts-gesetz") and guidelines for electronic scrap are in preparation.

The aim is a suitable waste disposal program and, as a preventative measure, a reduction in the content of hazardous damaging materials in such components. In order to conform to this procedure, detailed information about the materials and their quantities is needed.

This present overview answers questions put forward by customers as to the constituents and their function in the most important of Vishay Semiconductors' semiconductor products. Special significance is given to so-called "Hazardous Substances". It demonstrates that Vishay Semiconductors' products under normal operating conditions do not expose the applier or environment to any hazard. However, most products nevertheless contain small but necessary quantities of "Hazardous Substances" which can, if not treated correctly or through accidents, be released on a small scale into the environment.

The present information was produced with the greatest possible care. Any suggestions for improvement of this brochure are welcome.

Definitions

Vishay Semiconductors offers a wide range of semiconductor components including transistors, diodes and opto-electronic components. These have been manufactured in various standard packages.

On the following pages, these packages are listed together with their materials shown in weight percentages. In order to limit the number of tables, all components whose structure and composition are the same have been compiled in families. In many cases, different lead frames together with chips of different sizes may be used for the one package. This usually means that there may be slight differences in the quantities of the declared material. The weight percent is, however, valid for a representative sample of the relevant family. In order to sensibly reduce the number and quantities of materials contained in the respective components, quantities smaller than 0.1% by weight have been stated in the following list as **traces**. This is the case unless lower limits are forced by law, e.g. cadmium < 75 ppm and PCDD as well as PCDF (known as dioxin) < 2 ppb. In the lists themselves, details of content and composition are separated into the individual parts of the semiconductor component. The most important of these are:

Active element: The active element is either a silicon chip or, for optoelectronic components, a chip containing combinations of Ga (Al) (As, P). These are doped with very small amounts of boron, arsenic, phosphorus, zinc and germanium etc. The metallisation consists of thin layers of aluminium, gold or titanium. The chips are generally bonded to the lead frame with a silver epoxy and have gold or aluminium wires bonded to the lead frame.

Lead frame: For electrical connection, a metal lead frame made from alloys such as FeNi (42) or CuFe (2) and partly or totally plated with silver is commonly used. The metal alloys contain traces of silver, zinc and phosphorus. Part of the lead frame is also coated with tin/ lead.

Case: The semiconductor chip is protected from the environment by a case of glass, plastic or metal.

The glass is composed of oxides of silicon and lead together with boron and aluminium.

Plastic cases are composed of an epoxy resin filled with up to 70% by weight of quartz particles. Antimony trioxide and brominated epoxy resin (no TBA) are added as flame retardents. Antimony and bromine amount to about 1.6 and 1.0% respectively.

In use: In use, it is the content of hazardous substances which is of importance. In Germany, there are a number of lists which give the materials which are potentially hazardous to people and the environment, for example:

Appendix II and IV of the "Hazardous Materials Regulations", the TRGS 900 ("MAK-Wert-Liste") and the "Catalog of Materials Hazardous to the Water Supply". These lists, however, are only partially consistent.

The names used are often different for materials with the same chemical composition. Furthermore, the use of trivial and trade names often adds to the confusion.

Therefore, Vishay Semiconductors use for their descriptions that proposed by the Zentralverband Elektrotechnik und Elektronikindustrie e.V. (ZVEI; Central Association of Electrical Engineering and Electronic Industry) for the harmonization of the nomenclature of hazardous substances.

Instructions are given on the safety precautions to be used during storage and disposal by mechanical, chemical and thermal means of the more important chemicals (so-called "Leitchemikalien"). These are listed in the tables in the order of their potential risk. Their effect upon people and the environment are also listed and any special precautions emphasized.

Notes:

The following information has been prepared to be as exact and reliable as possible.
The manufacture of semiconductor components is, however, subject to regular change without special notification.
The publication of this brochure excludes any responsibility resulting from its use.

Explanation of Abbreviations

While the information on weight percent is believed correct, discrepancies depending upon component type may be possible.

1) Material information etc. Material listed as "Material Hazardous in Production"
2) S: Trace material < 0.1% by weight;
   Cd < 75 ppm; concerning Cd see ***)
   PCDD and PCDF < 2 ppb

*) Dioxin content - lies below agreed limits

**) No. 85 "Rules for Hazardous Materials", to be replaced as soon as a technically suitable alternative material is available

***) Traces of cadmium can only be found in lead frames made of copper

CMT: Material containing carcinogens, mutagens or terratogens

Tox: Material is toxic or very toxic

S Material with allergy producing characteristics

HAL Halogen containing material

WKG Material hazardous to the water supply

L Storage, suitable for disposal

D Disposable

M Mechanical disposal

N Chemical disposal

T Thermal disposal

H Handling

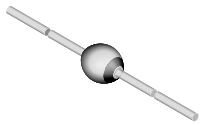
Ozone Depleting Substances

The use of Ozone Depleting Substances has been totally eliminated by Vishay Semiconductors and by doing so meets the legal requirements as defined in the following documents.

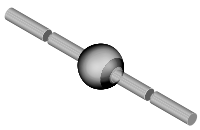
1. The "Montreal Protocol" together with the "London Amendments" Appendix A, B, and the "List of Transitional Substances"
2. "Clean Air Act", Amendments 1990, "Environmental Protection Agency" (EPA), USA, Class I and II - Ozone Depleting Substances
3. "European Council Resolution" number 88/540/EEC and 91/690/eec Appendix A, B and C (Transitional Substances)

Vishay Semiconductors guarantees that its components do not contain, and are manufactured without, the use of Ozone Depleting Substances

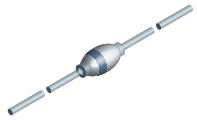
Contents of a Diode in Sintered Glass Package SOD57

				mg	ppm
 Total weight 370 mg	**Leads, tinned**		**85,90 %**		
	Copper	Cu	58,30 %	185,29	500,797
	Iron	Fe	22,15 %	70,40	190,269
	Molybdenum	Mo	18,55 %	58,96	159,345
	Tin	Sn	0,50 %	1,59	4,295
	Lead	Pb	0,20 %	0,64	1,718
	Silver	Ag	0,10 %	0,32	0,859
	Carbon	C	0,10 %	0,32	0,859
	Oxygen	O_2	0,10 %	0,32	0,859
	Traces of Mn, P, S				
	Package, glass:		**13,80 %**		
		PbO	42,00 %	21,45	57,960
		SiO_2	38,00 %	19,40	52,440
		B_2O_3	15,00 %	7,66	20,700
		Al_2O_3	5,00 %	2,55	6,900
	Silicon chip:		**0,30 %**		
	Silicon	Si	90,00 %	1,00	2,700
	Aluminum	Al	10,00 %	0,11	0,300
	Traces of P, Ga, Pt (Dopant)				

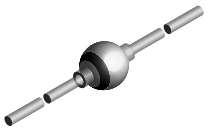
Contents of a Diode in Sintered Glass Package SOD64

				mg	ppm
 Total weight 860 mg	**Leads, tinned**		**85,90 %**		
	Copper	Cu	58,30 %	430,69	500,797
	Iron	Fe	22,15 %	163,63	190,269
	Molybdenum	Mo	18,55 %	137,04	159,345
	Tin	Sn	0,50 %	3,69	4,295
	Lead	Pb	0,20 %	1,48	1,718
	Silver	Ag	0,10 %	0,74	0,859
	Carbon	C	0,10 %	0,74	0,859
	Oxygen	O_2	0,10 %	0,74	0,859
	Traces of Mn, P, S				
	Package, glass:		**13,80 %**		
		PbO	42,00 %	49,85	57,960
		SiO_2	38,00 %	45,10	52,440
		B_2O_3	15,00 %	17,80	20,700
		Al_2O_3	5,00 %	5,93	6,900
	Silicon chip:		**0,30 %**		
	Silicon	Si	90,00 %	2,32	2,700
	Aluminum	Al	10,00 %	0,26	0,300
	Traces of P, Ga, Pt (Dopant)				

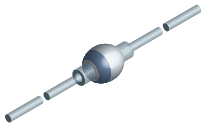
Contents of a Diode in Sintered Glass Package G1

				mg	ppm
 Total weight 560 mg	**Leads, tinned**		**62,19 %**		
	Copper	Cu	77,68 %	270,53	483,092
	Molybdenum	Mo	20,64 %	71,88	128,360
	Tin	Sn	1,31 %	4,56	8,147
	Lead	Pb	0,23 %	0,80	1,430
	Silver	Ag	0,08 %	0,28	0,498
	Phosphorus	P	0,06 %	0,21	0,373
	Traces of S, O_2, C				
	Package, glass:		**37,58 %**		
		ZnO	62,70 %	131,95	235,627
		B_2O_3	24,00 %	50,51	90,192
		SiO_2	10,00 %	21,04	37,580
		PbO	2,80 %	5,89	10,522
		Sb_2O_3	0,50 %	1,05	1,879
	Traces of P, Pt				
	Silicon chip:		**0,23 %**		
	Silicon	Si	93,55 %	1,20	2,152
	Aluminum	Al	6,45 %	0,08	0,148

Contents of a Diode in Sintered Glass Package G3

				mg	ppm
 Total weight 1100 mg	**Leads, tinned**		**62,19 %**		
	Copper	Cu	77,84 %	532,50	484,087
	Molybdenum	Mo	21,06 %	144,07	130,972
	Tin	Sn	0,83 %	5,68	5,162
	Lead	Pb	0,15 %	1,03	0,933
	Silver	Ag	0,07 %	0,48	0,435
	Phosphorus	P	0,05 %	0,34	0,311
	Traces of S, O_2, C				
	Package, glass:		**37,58 %**		
	Zinc Oxide	ZnO	62,70 %	259,19	235,627
		B_2O_3	24,00 %	99,21	90,192
		SiO_2	10,00 %	41,34	37,580
		PbO	2,80 %	11,57	10,522
		Sb_2O_3	0,50 %	2,07	1,879
	Traces of P, Pt				
	Silicon chip:		**0,23 %**		
	Silicon	Si	93,57 %	2,37	2,152
	Aluminum	Al	6,43 %	0,16	0,148

Contents of a Diode in Sintered Glass Package G4

				mg	ppm
 Total weight 1040 mg	**Leads, tinned**		**62,19 %**		
	Copper	Cu	69,09 %	446,86	429,671
	Molybdenum	Mo	29,63 %	191,64	184,269
	Tin	Sn	0,95 %	6,14	5,908
	Lead	Pb	0,17 %	1,10	1,057
	Silver	Ag	0,10 %	0,65	0,622
	Phosphorus	P	0,06 %	0,39	0,373
	Traces of S. O_2, C				
	Package, glass:		**37,58 %**		
	Zinc Oxide	ZnO	62,70 %	245,05	235,627
		B_2O_3	24,00 %	93,80	90,192
		SiO_2	10,00 %	39,08	37,580
		PbO	2,80 %	10,94	10,522
		Sb_2O_3	0,50 %	1,95	1,879
	Traces of P, Pt				
	Silicon chip:		**0,23 %**		
	Silicon	Si	93,12 %	2,23	2,142
	Aluminum	Al	6,88 %	0,16	0,158

Significant Materials for Disposal

No.	Material and/or Group [1]	C M T	T	S	H AL	W G K	Available in the Compound Used for	Part in [2] Weight Percent	L	D	M	N	T	H
1	Lead and compounds		[2]			[2]	Package glass, lead	6.0			[2]	[2]	[2]	
2	Molybdenum and compounds		[2]				Lead	15.9				[2]		

Note: *), **), ***), [1], [2], CMT, T