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-Wirtschaftsgesetz”) 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 overview answers questions put forward by customers as to the constituents and their function in the most important of Vishay Semiconductor’s semiconductor products. Special significance is given to so-called “Hazardous Substances”. It demonstrates that Vishay Semiconductor 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 Semiconductor 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 series 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. Vishay Semiconductor therefore for their descriptions use those 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.

 Statements are made 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.
Vishay Semiconductors

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
   Material containing carcinogens, mutagens or terratogens
   Material is toxic or very toxic
   Material with allergy producing characteristics
   Halogen containing material
   Material hazardous to the water supply
   Storage, suitable for disposal
   Disposable
   Mechanical disposal
   Chemical disposal
   Thermal disposal
   Handling

Ozone Depleting Substances
The use of Ozone Depleting Substances has been totally eliminated by Vishay Semiconductor 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

Vishay Semiconductor guarantees that its components do not contain and are manufactured without the use of Ozone Depleting Substances.
The Constituents of Package Forms

Package form 22:

Epoxy resin (55.0%)
- 50% resin
- 50% hardener

Lead frame (44.7%)
- 96% copper
- 2% iron
- 2% silver
- Traces of Ni, Ag, Zn, P, Cd

Silver epoxy (< 0.1%)
- 80% silver
- 10% resin
- 10% hardener
- Traces of Cl, Na, K

IR chip (< 0.1%)
- 50.0% gallium
- 50.0% arsenic
- Traces of Al, Au, Zn, Ge, Ti

Detector chip (< 0.1%)
- 99.9% silicon
- Traces of Ag, Al, Au, Sb, Ti, SiO₂

Bond wire (< 0.1%)
- 99.99% gold
- Traces of BE, Mg

Total weight 130 mg

Significant Materials for Disposal

<table>
<thead>
<tr>
<th>No.</th>
<th>Material and/or Group ¹⁾</th>
<th>C</th>
<th>T</th>
<th>H</th>
<th>W</th>
<th>M</th>
<th>O</th>
<th>A</th>
<th>G</th>
<th>L</th>
<th>K</th>
<th>Available in the Compound Used for</th>
<th>Part in ²⁾</th>
<th>Weight Percent</th>
<th>L</th>
<th>D</th>
<th>M</th>
<th>N</th>
<th>T</th>
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</tbody>
</table>

Note: *), **), ***), ¹⁾, ²⁾, CMT, T etc.: see ‘Explanation of Abbreviations’, page 2

Package form 23:

Epoxy resin (31.1%)
- 47.0% resin
- 50.0% hardener
- 3.0% filter color

Mold (20.1%)
- 70.0% PBTP
- 30.0% glass fiber

Lead frame (48.8%)
- 98.8% copper
- 1.2% iron
- Traces of Ni, Ag, Zn, P, Cd

Bond wire (< 0.1%)
- 99.99% gold

Emitter chip (< 0.1%)
- 50.0% gallium
- 50.0% arsenic and phosphorus
- Traces of Al, Au, Zn, Ge, Si₃N₄

Detector chip (< 0.1%)
- 99.0% silicon
- Traces of Al, SiO₂, Si₃N₄

Silver epoxy (< 0.1%)
- 80% silver
- 10% resin
- 10% hardener
- Traces of Cl, Na, K

Total weight 150 mg

Significant Materials for Disposal

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<th>C</th>
<th>T</th>
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<th>W</th>
<th>M</th>
<th>O</th>
<th>A</th>
<th>G</th>
<th>L</th>
<th>K</th>
<th>Available in the Compound Used for</th>
<th>Part in ²⁾</th>
<th>Weight Percent</th>
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<th>D</th>
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<td>Traces</td>
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Note: *), **), ***), ¹⁾, ²⁾, CMT, T etc.: see ‘Explanation of Abbreviations’, page 2
**Package form 24:**

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<td>TCSS2100/TCST2000/TCST2x0x</td>
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<td>TCST1210</td>
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<td>TCST1230</td>
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<tr>
<td>TCST5123</td>
<td>395</td>
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<tr>
<td>TCST5250</td>
<td>640</td>
</tr>
</tbody>
</table>

- **IR emitting diode**
  - **Epoxy resin** (55.0%)
  - 55.5% resin
  - 45.5% hardener
  - **Lead frame** (44.7%)
  - 98.8% copper
  - 1.2% iron
  - Traces of Ni, Ag, Zn, P, Cd

- **Emitter chip** (< 0.1%)
  - 50.0% gallium
  - 50.0% arsenic and phosphorus
  - Traces of Al, Au, Zn, Ge, Si3N4

- **Silver epoxy** (< 0.1%)
  - 80% silver
  - 10% resin
  - 10% hardener
  - Traces of Cl, Na, K

- **Bond wire** (< 0.1%)
  - 99.99% gold

- **IR photodetector**
  - **Epoxy resin** (54.0%)
  - 55.5% resin
  - 45.5% hardener
  - **Lead frame** (45.7%)
  - 98.8% copper
  - 1.2% iron
  - Traces of Ni, Ag, Zn, P, Cd

- **Detector chip** (< 0.1%)
  - 50.0% silicon
  - Traces of SiO2, Al, Al3N4

- **Silver epoxy** (< 0.1%)
  - 80% silver
  - 10% resin
  - 10% hardener
  - Traces of Cl, Na, K

- **Bond wire** (< 0.1%)
  - 99.99% gold

- **Housing**
  - 100% Polycarbonate

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**Significant Materials for Disposal**

<table>
<thead>
<tr>
<th>No.</th>
<th>Material and/or Group 1)</th>
<th>C</th>
<th>T</th>
<th>H</th>
<th>W</th>
<th>Available in the Compound</th>
<th>Part in 2)</th>
<th>Weight Percent</th>
<th>L</th>
<th>D</th>
<th>M</th>
<th>N</th>
<th>T</th>
<th>H</th>
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<td>●</td>
<td>●</td>
<td>●</td>
<td>Chip</td>
<td>Traces</td>
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<td></td>
<td></td>
</tr>
</tbody>
</table>

Note: *)**, **), ***), 1), 2), CMT, T etc.: see ‘Explanation of Abbreviations’, page 2
Package form 25:

Vishay Semiconductors

TCYS5201
Total weight 1100 mg

TCYS6201
Total weight 2700 mg

- **Housing**
  100% Polycarbonate

- **Connector** (10%)
  40% polyamid
  59% copper
  1% SnPb (60/40)

- **IR emitting diode**
  Epoxy resin (34.5%)
  50.0% resin
  50.0% hardener
  Traces of N, Fe, C, Cl

  Lead frame (65.2%)
  98.8% copper
  1.2% iron
  Traces of Ni, Ag, Zn, P, Cd ***)

- **IR photodetector**
  Epoxy resin (29%)
  50.0% resin
  50.0% hardener
  Traces of Fe, C, Cl

  Lead frame (70.7%)
  89.0% iron
  4.1% copper
  2.4% silver
  4.5% SnPb
  Traces of Ni, Zn, P

- **Bond wire** (< 0.1%)
  99.99% gold
  Traces of Be, Mg

- **IR Photodetector** (< 0.1%)
  99.0% silicon
  Traces of Ag, Al, Au, Sb, Ti, SiO₂

- **Silver epoxy** (< 0.1%)
  80.0% silver
  10.0% resin
  10.0% hardener
  Traces of Cl, Na, K

**Significant Materials for Disposal**

<table>
<thead>
<tr>
<th>No.</th>
<th>Material and/or Group 1)</th>
<th>C</th>
<th>T</th>
<th>H</th>
<th>W</th>
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<td>O</td>
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<td>G</td>
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<td></td>
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<td>X</td>
<td>S</td>
<td>L</td>
<td></td>
<td>Percent</td>
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<td>Arsenic</td>
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<td>Chip</td>
<td>Traces</td>
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<tr>
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<td>Lead and - compounds</td>
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<td></td>
<td></td>
<td>Lead frame</td>
<td>0.4</td>
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</tbody>
</table>
Package form 26:

Epoxy resin (31.1%)
- 47.0% resin
- 50.0% hardener
- 3.0% filter color

Mold (20.1%)
- 70.0% PBTP
- 30.0% glass fiber

Lead frame (48.8%)
- 98.8% copper
- 1.2% iron
- Traces of Ni, Ag, Zn, P, Cd

Bond wire (< 0.1%)
- 99.99% gold

Emitter chip (< 0.1%)
- 50.0% gallium
- 50.0% arsenic and phosphorus
- Traces of Al, Au, Zn, Ge, Si₃N₄

Detector chip (< 0.1%)
- 99.0% silicon
- Traces of Al, SiO₂, Si₃N₄

Silver epoxy (< 0.1%)
- 80% silver
- 10% resin
- 10% hardener
- Traces of Cl, Na, K

Significant Materials for Disposal

<table>
<thead>
<tr>
<th>No.</th>
<th>Material and/or Group 1)</th>
<th>C</th>
<th>T</th>
<th>H</th>
<th>W</th>
<th>Available in the Compound</th>
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<th>Weight Percent</th>
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<td>○</td>
<td>Chip</td>
<td>Traces</td>
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</tbody>
</table>

Note: *)**, ***) 1), 2), CMT, T etc.: see ‘Explanation of Abbreviations’, page 2
Vishay Semiconductors

Package form 27:

- **Housing**
  100% Polycarbonate

- **IR emitting diode**
  **Epoxy resin** (34.5%)
  50.0% resin
  50.0% hardener
  Traces of N, Fe, C, Cl

- **Lead frame** (65.2%)
  98.8%copper
  1.2% iron
  Traces of Ni, Ag, Zn, P, Cd ***)

- **IR emitting diode**
  (0.2%)
  50.0%gallium
  50.0%arsenic and phosphorus
  Traces of Al, Au, Zn, Ge, Si₃N₄

- **Silver epoxy** (< 0.1%)
  80% silver
  10% resin
  10% hardener
  Traces of Cl, Na, K

- **IR photodetector**
  **Epoxy resin** (29%)
  50.0%resin
  50.0%hardener
  Traces of Fe, C, Cl

- **Lead frame** (70.7%)
  89.0%iron
  4.1% copper
  2.4% silver
  4.5% SnPb
  Traces of Ni, Zn, P

- **Bond wire** (< 0.1%)
  99.99% gold
  Traces of Be, Mg

- **IR Photodetector** (< 0.1%)
  99.0%silicon
  Traces of Ag, Al, Au, Sb, Ti, SiO₂

- **Silver epoxy** (< 0.1%)
  80.0%silver
  10.0%resin
  10.0%hardener
  Traces of Cl, Na, K

**Significant Materials for Disposal**

<table>
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<th>No.</th>
<th>Material and/or Group ¹</th>
<th>C T</th>
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<td>Lead frame</td>
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Note: ¹), **), ***) ¹), ²), CMT, T etc.: see ‘Explanation of Abbreviations’, page 2
Vishay Semiconductors

Package form 28:

- **Housing**
  100% Polycarbonate
- **IR emitting diode**
  - **Epoxy resin** (34.5%)
    50.0% resin
    50.0% hardener
    Traces of N, Fe, C, Cl
  - **Lead frame** (65.2%)
    98.8% copper
    1.2% iron
    Traces of Ni, Ag, Zn, P, Cd
- **IR emitting diode**
  (0.2%)
  50.0% gallium
  50.0% arsenic and phosphorus
  Traces of Al, Au, Zn, Ge, Si₃N₄
- **Silver epoxy** (< 0.1%)
  80% silver
  10% resin
  10% hardener
  Traces of Cl, Na, K

- **IR photodetector**
  - **Epoxy resin** (29%)
    50.0% resin
    50.0% hardener
    Traces of Fe, C, Cl
  - **Lead frame** (70.7%)
    89.0% iron
    4.1% copper
    2.4% silver
    4.5% SnPb
    Traces of Ni, Zn, P
  - **Bond wire** (< 0.1%)
    99.99% gold
    Traces of Be, Mg
  - **IR Photodetector** (< 0.1%)
    99.0% silicon
    Traces of Ag, Al, Au, Sb, Ti, SiO₂
  - **Silver epoxy** (< 0.1%)
    80.0% silver
    10.0% resin
    10.0% hardener
    Traces of Cl, Na, K

**Significant Materials for Disposal**

<table>
<thead>
<tr>
<th>No.</th>
<th>Material and/or Group ¹)</th>
<th>C</th>
<th>T</th>
<th>H</th>
<th>W</th>
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<th>Part in ²)</th>
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<th>L</th>
<th>D</th>
<th>M</th>
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<td>●</td>
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</tr>
<tr>
<td>2</td>
<td>Lead and - compounds</td>
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</table>

Note: ¹), ²), ³), ¹), ²), CMT, T etc.: see 'Explanation of Abbreviations', page 2
Package form 29:

TCPT1200
Total weight 150 mg

TCUT1200
Total weight 150 mg

Molding Compound
(77.6%)
71.4% SiO₂
26% Epoxy resin
1.6% Sb
(as antimony trioxide)
Traces of
N,Fe,C,Cl

Lead frame (65.2%)
58% copper
42% nickel
Traces of
Ag, Zn, P, Cd

Emitter – Chip
(<0.1%)
50.0% gallium
50.0% arsenic and phosphorus
Traces of
Al, Au, Zn, Ge, Si₃N₄

Bond wire (< 0.1%)
99.99% gold

Detector–Chip (< 0.1%)
99.0% silicon
Traces of
Al, Al₃, N₄, SiO₂

Silver epoxy (< 0.1%)
78.0% silver
11.0% resin
11.0% hardener

Significant Materials for Disposal

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<tr>
<th>No.</th>
<th>Material and/or Group ¹)</th>
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Note: *)**, ***, *, ¹), ²), CMT, T etc.: see 'Explanation of Abbreviations', page 2