# EU DIRECTIVE 2002/95/EC „ROHS“

## SPECIFIC QUESTIONS FOR EXEMPTION 5

1. Please specify in detail the “**electronic components**” in the wording above where lead is used in glass.

SCHOTT Electronic Packaging uses lead-oxide based glasses, so called “solder-glasses” to attach optical elements like windows or lenses into metal components. This assembly is part of a hermetic package (“Cap”) for opto-electronic devices like laser diodes, photodectors etc.

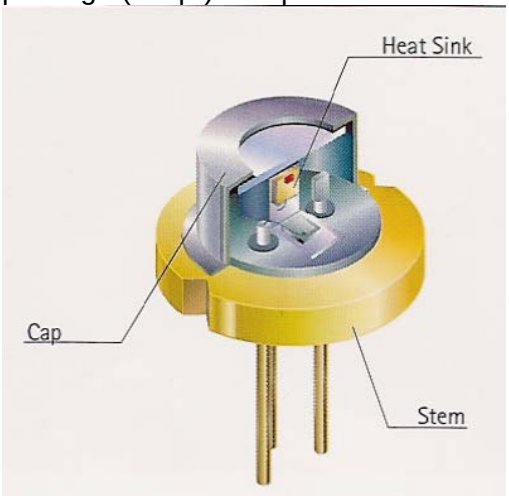
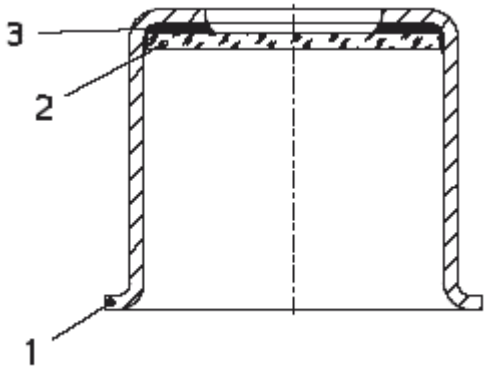



**Figure 1, TO56 Laser Diode Package**




1 = Metal Can
2 = Glass Window (PbO-free)
3 = PbO containing solder glass

**Figure 2, Cross Section of a typical Window Cap**

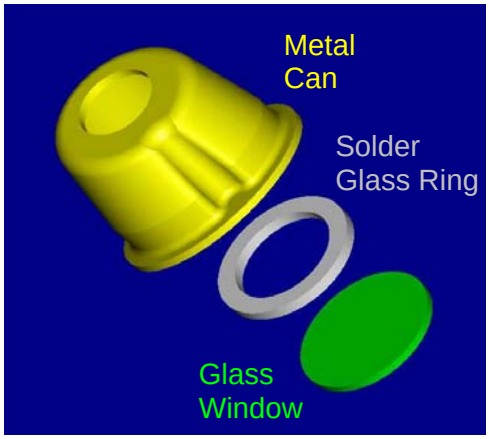
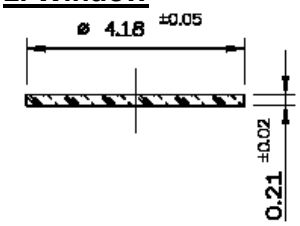



**Figure 3, Exploded View of a typical Window Cap**

2. Please state the **amount of lead** used per application, the lead content in the homogeneous material, the annual production volume as well as the number of applications put on the EU market annually in applications falling under the scope of RoHS for
   a. ~~cathode ray tubes~~ Not applicable
   b. electronic components (if possible specified in more detail, see question 1)
   c. ~~fluorescent tubes.~~ Not applicable

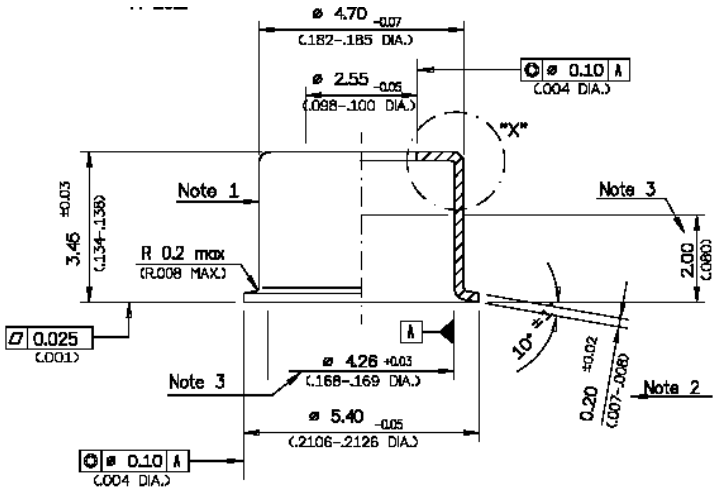
## Estimated Solder Glass Content in Standard Window Cap

### 1. Window



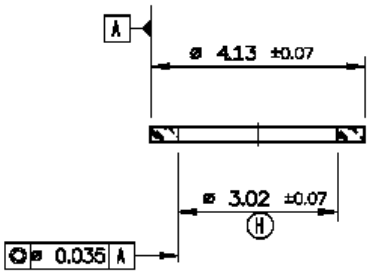

| | |
|---|---|
| Density | 2,51g/cm³ |
| Volume | 2,88mm³ |
| | 2,88E-03cm³ |
| Mass | 7,23E-03g |

### 2. Metal Can




| | |
|---|---|
| Density | 8,20g/cm³ |
| Volume | 9,35E-03cm³ |
| Mass | 7,67E-02g |

## 3. Solder Glass Ring




**Solder Glass Content** ***9,3%***

PbO Content in Solder Glass
Appr. 75%

**PbO Content in Cap** ***7,0%***

| | |
|---|---|
| Density | 4,60g/cm³ |
| Volume | 1,87mm³ |
| | 1,87E-03cm³ |
| Mass | 8,60E-03g |

| | |
|---|---|
| Contents of PbO in the homogenous material solder glass | Appr. 75% |
| Annual Production Qty for Hermetic Caps using solder Glass | 25 Mio Pcs. |
| Annual Consumption of PbO | Appr. 150Kg |
| Sales volume for this type of hermetic optical caps into the EU | 10% |

Applications are:

- Fiber Optic Data Communication Components
  - Laser Diodes for Transmit Modules
  - Photodiodes and Avalanche Photo Diodes for Receive Components
- Laser Packaging
- Optical Sensor Devices
  - Laser Diode based Gas Sensors
  - Infrared Sensors
  - Photodiodes and -resistors
- Optical MEMS Packaging
- High Power LED Packaging

3. Please provide detailed information about the **specific function** and related performance criteria of lead in glass for
   a. ~~cathode ray tubes~~ Not applicable
   b. electronic components (if possible specified in more detail, see question 1)
   c. ~~fluorescent tubes.~~ Not applicable

In our cap assemblies, the lead based solder glass serves as attachment material for the optical element. The overall assembly must meet the following requirements, which makes the use of solder glass inevitable

- Gas tight seal (Hermeticity better than $1x10^{-8}$ mbar*l/s)
- No outgassing
- Mechanically strong bond, Assembly has to pass stringent shock (typ. 1500g acceleration) and vibration testing
- Chemical resistance (No performance change after 1000h 85°C / 85% r. Humidity)
- Hermeticity must maintain unchanged after 15 cycles thermal shock Liquid to liquid (-65°C <> 150°C)
- Hi-Reliability , 10-15Years Lifetime required

In order to maintain the quality of the optical components (windows, lenses), the lead based solder glass must have a working temperature of less than 500°C (<450°C preferred). Higher temperatures during the sealing process would affect the optical components (i.e. window will start to bend, as the glass softens)
PbO is used to produce glasses with such low working temperature, yet maintaining an acceptable level of environmental resistance.

4. What **technical characteristics** do substitutes need to fulfil as a minimum requirement?

The following requirements have to be met by a substitute glass as well :

- Gas tight seal (Hermeticity better than $1x10^{-8}$ mbar*l/s)
- No outgassing
- Mechanically strong bond, Assembly has to pass stringent shock (typ. 1500g acceleration) and vibration testing
- Chemical resistance (No performance change after 1000h 85°C / 85% r. Humidity)
- Hermeticity must maintain unchanged after 15 cycles thermal shock Liquid to liquid (-65°C <> 150°C)
- Low Cost (Excludes the usage of metalized windows and metal solder)
- Working temperature less than 500°C

5. Please provide evidence that manufacturers have put effort in **research on alternatives** for lead. What are the alternatives to lead and which ones are (likely to be) used as substitutes? Are there any results about strengths and weaknesses expressed in results relating to (technical) performance criteria?

SCHOTT has started PbO substitution project for solder glasses in the year 2000. New glass systems have been developed for replacement of PbO containing solder glasses. These new glass were based on the following substitutes:

- Bismuth-Oxide, $Bi_2O_3$
- Phospate Glasses $P_2O_5$

Development for these glasses was mainly done for glass to glass or glass to ceramic joints. In a separate project which was launched 2004, we tested all these new systems for usability for metal to glass joints. The following results have been achieved:

| Glass System | Weaknesses | Positive Findings | Further conclusion |
|---|---|---|---|
| $Bi_2O_3$ | • Sealing Temperature 550-570°C (dependant on Cap geometry)<br>• Optical elements damaged by high sealing temperature<br>• Metal surface requirement cannot be met (Damp Heat, Bellcore Spec GR468) | • Mechanically good bonding to metal and glass<br>• Chemical resistance of solder glass improved compared to PbO | • Launch of new project for improved $Bi_2O_3$ glass with lower sealing temp |
| $Bi_2O_3$ Next Gen. Glasses | • Sealing Temperature only reduced to 530-550°C<br>No glass composition identified with lower seal temp. (appr. 50 new glass compositions tested) | • See above | • No Solution found with $Bi_2O_3$ system |
| $P_2O_5$ | • No bond to suitable metal surfaces<br>• Chemical resistance no adequate for Cap application | • None | • No further activities |
| $SnO_2$-$P_2O_5$ | • Environmental Stabilitynot adequate | • Sealing Temperature requirement <500°C met<br>• Bond between Solder glass and metal achieved | • No further activities |
| Metalized Windows & Metal Solder | • Metalization process is too costly for this application (costs are about 5-10x too high)<br>• Not applicable to all products (i.e. ball lenses) | • | • No further activities |

6. Are manufacturers still **investigating alternatives**?
   a. If yes, please provide a **roadmap** or similar evidence showing until when they intend to replace lead in glass in the applications mentioned above.
   b. If no, please explain and justify why no further research has been undertaken against the background that the RoHS Annex is subject to regular revisions.

After spending 5,5 manyears of research, and thorough testing of available substitute systems, we see no adequate replacement for PbO for this application..

7. Assuming the current exemption will be given an **expiry date**, what date do you think is technologically feasible for industry?

Please see §6.