Answer to ECHA public consultation for Diboron Trioxide

Comments on the draft recommendation of substances for inclusion in Annex XIV

CONTENT

1) General comments on the recommendation to include the substance in Annex XIV

General context

Glass frit description

Conditions of use

Use descriptors

Non relevance of Wide Dispersive Use criteria

2) Transitional arrangements Comments on the proposed dates

Tentative Time line for glass frits substitution

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1) General comments on the recommendation to include the substance in Annex XIV

General context

Semiconductor manufacturing uses highly sophisticated technologies and relies on a complex global supply chain in the world. Manufacturing takes place in a highly controlled environment, ensuring minimization of product contamination risks and employees' exposure control.

Glass frits description

Glass frits paste is a mixture of an extremely finely grinded glass, with an inert filler material, together with a binding resin and solvent. These components mixed together form a glass frits paste.

Lead monoxide and Diboron trioxide are among the constituents of the formulation of a Low-Temperature (Low-T) melting glass (i.e. the glass component in the glass frits paste). Lead monoxide lowers the melting Temperature of the glass, rendering the glass compatible with the Aluminium

metal in the device. Diboron trioxide gives the glass properties of chemical and mechanical resistance.

Based on the chemical reactions for production of glass and frits, Lead monoxide and Diboron trioxide are used specifically in order to be transformed into another substance (i.e. the glass or frits), rather than being added to other substances to modify their properties. Therefore, the use is in line with the definition of intermediates and exempt from authorization. www.glassallianceeurope.eu

During the glass "melting" process, the different raw materials react chemically to produce the substance glass, which is an amorphous network of elements bonded together with oxygen ions between cations. For practical reasons, the elemental analyses of glass are expressed in the form of their oxides, but this must not be confused with a mixture of the different oxides. In conclusion, the **substance glass does not contain any raw material used as starting materials** and particularly does not contain any **Lead monoxide** or **Diboron trioxide.**

Glass frits used in Semiconductor Manufacturing Industry may be described, however, in terms of Diboron trioxide (CAS 1303-86-2). In the Draft background document for Diboron trioxide the use of technical glass frits is not mentioned at all, thus implying that those uses are irrelevant for the whole authorization scope due to very limited volumes used for this selected electronic application (Draft background document for Diboron trioxide - ECHA 01/09/2014). Anyhow a response to the current consultation is submitted to inform ECHA and the Commission on the relevance of this specific industrial use.

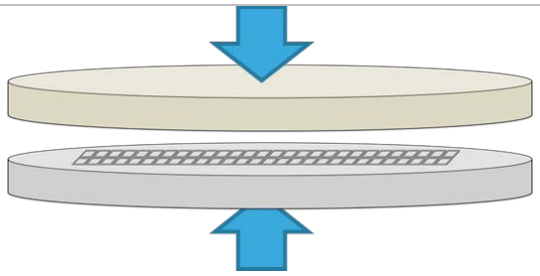
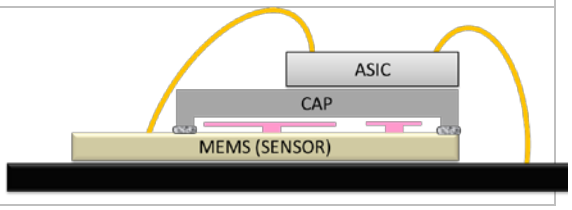
In conclusion, due to the above described "melting" process, the SVHC **Diboron trioxide is not present in the glass as such and Boron, only, is chemically bonded in the glass amorphous structure**. For this reason, it is believed that **the use of frits in the specific application of MEMS manufacturing in the semiconductor industry is to be considered out of the scope of the authorization**.

Conditions of use

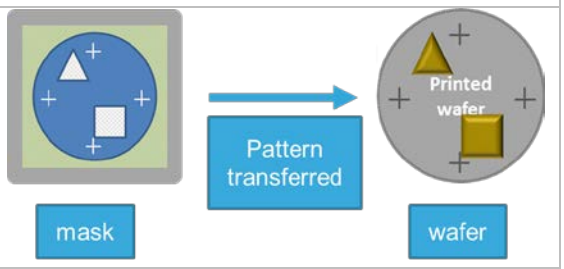
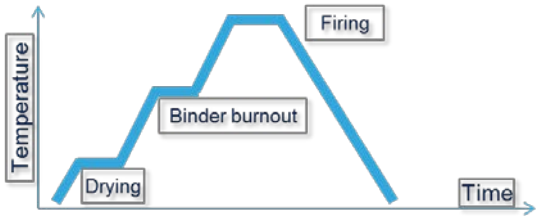
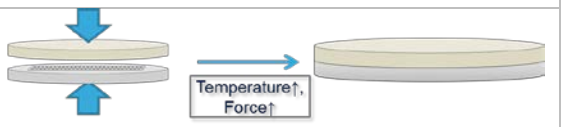
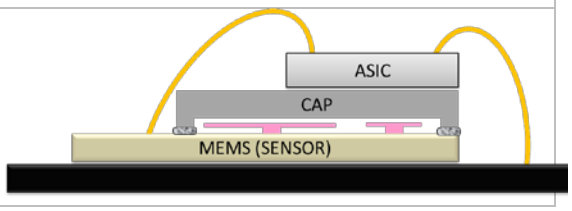
Glass frits are used in semiconductor manufacturing, with the scope of hermetically sealing microelectronic devices.

Low Temperature (Low-T) Boron trioxide based glass frits are used in wafer-to-wafer bonding process of MEMS (Micro Electro Mechanical Systems) devices. MEMS devices, such as accelerometers or gyroscopes, are well-known components of smartphones, tablets and several games consoles.

In the table below, a simplified MEMS process flow is presented, with wafer-to-wafer bonding. All processes are performed in clean room environment and in controlled equipment.

Process step	Description	Image
Make Sensor wafer	Where actual Sensor device is built.	
Make Cap wafer	Role: protect Sensor device from environment; **Glass Frits application** via Screen Printing	
Bond Sensor wafer with Cap wafer	Bonding Technology: Glass Frit	
Dice & Assemble	In package with electronics driver chip (ASIC)	

In terms of processing, glass frits paste is screen printed on the wafer, transformed into melted glass at high temperature and used to bond 2 wafers together).

Process step	Description	Image
Screen Printing	Glass Frits Paste Pattern transfer	
Firing	Thermal treatment in batch oven Transform Glass Frits Paste (Binder + solvent + Glass powder) --> Glass	
Bonding	Thermal Treatment on Bonder Equipment "Soften" Glass --> squeeze wafers together	
Dice & Assemble	In package with electronics driver chip (ASIC)	

The used screens are cleaned in dedicated closed circuit screen cleaner equipment. The solvent used for cleaning the screens is filtered and re-circulated. The spent solvent is collected separately in a dedicated solvent drain, and sent for incineration. The glass frit contaminated filters are collected separately and sent for incineration. All operations take place under local exhaust ventilation and ensuring appropriate solvent containment.

The whole process takes place in a controlled environment applying strict risk management measures, ensuring no release to the environment and controlled employees' exposure.

Exhaust are installed in all relevant area and **air emissions** are regularly monitored ensuring all results for **B < 0.132 mg/m^3**

Controlled discharge to water is expected being plant **waste water** regularly monitored ensuring all results for **B < 0.1 mg/l** while applicable emission limit is 4 mg/l.

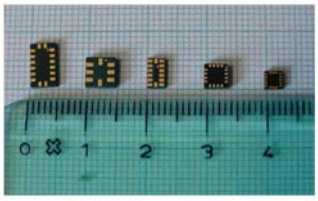
Boron being present in the glass paste is not expected to be re combined into Diboron trioxide during the process, while it is found embedded in a glass matrix in the final product.

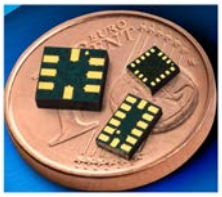
Glass frits is used for a total quantity of **450 Kg/year** in one site, equivalent to a theoretical consumption of **60 Kg/year of Diboron trioxide**, to the **0.007 %** of the total quantity of Diboron

trioxide in the authorization scope (Draft background document for Diboron trioxide - ECHA 01/09/2014).

This quantity is relevant to the production of 500 Million unit/y electronics components. Each electronic component may contain about 0.001 mg of Boron in a concentration up to 0.009 %, depending on the component weight.

Here below picture of MEMS plastic packages with thickness of less than 1.0 mm ranging from 7x5 mm^2 , 5x5 mm^2 , 3x5 mm^2 , 4x4 mm^2 ,3x3 mm^2





Glass frits are imported into Europe and, due to low quantity used, **are not registered** for the specific use in the semiconductor industry.

Use descriptor

The here below table reports the relevant descriptor as per Appendix R.12.1 to R.12.6 of the ECHA Guidance on Use Descriptor System (R12) and based on the ECHA-10-R-005-EN publication EXPOSURE SCENARIOS FOR THE SEMICONDUCTOR INDUSTRY EXAMPLES – August 2010

Sector of use (SU)	SU 3	Industrial manufacturing
	SU 16	Manufacturing of computer, electronic and optical product, electrical equipment
Chemical product category (PC)	PC1	Adhesives, sealants
Process category (PROC)	PROC 2	Use in closed, continuous process with occasional controlled exposure (e.g. sampling) - Industrial setting; (1)
Article category (AC)	AC2	Electric and electronic articles included (2)
Environmental release category	ERC5	Industrial use resulting in inclusion into or onto a matrix (2)

(1) Some process could take place not only in continuous process but also in batch operations with occasional control exposure, only
(2) Article category and Environmental release category are relate to glass frits

Non applicability of the wide dispersive criteria

With reference to the Draft background document for Boron trioxide - ECHA 01/09/2014 - there is a further clarification need: the total quantity of glass frit paste used in one industrial site is **450 Kg/y**, only, and the number of potentially exposed employees is very limited (40 employees) therefore the use of frits in the specific application of MEMS manufacturing in the semiconductor industry **cannot be considered to contribute to the wide dispersive use criteria for prioritization**.

There is no release to the environment from the article (semiconductor device) since the Boron trioxide, as already explained, is not present in the glass as such and Boron is chemically bonded in the glass amorphous structure. Moreover the semiconductor device is assembled into a matrix resin, to produce the semiconductor component, finally used in the electric or electronic equipment.

Waste of electric and electronic components are managed according to the WEEE Directive, **therefore there is no consumers exposure.**

2) Transitional arrangements Comments on the proposed dates

Time line for glass frits substitution

As of today, all alternative glass frits materials contain Boron. As for all changes in the semiconductor industry, implementation implies long time research project with associated costs and investments. Alternative technologies exist, but not all technologies are compatible with the processing of MEMS devices.

Phosphorus, zinc, tin, bismuth, etc. and their relatives oxides have been investigated as materials to be used as a constituent element of glass frits used as a wafer-to-wafer bonding and sealing layers for MEMS devices.

Up to now, **the presence of Boron is needed to ensure the relevant mechanical characteristics** as of those Boron containing glass frits.

However, these new type of glasses and glass frits are still in the investigation phase and have to fully demonstrate to meet the requirements necessary for substituting adequately the described Boron-based glass frits application.

Among the requirements to meet, some must be taken into account: the **sealing properties** (MEMS gyroscopes sensors, in order to work, must operate in a strict vacuum environment) and the **excellent mechanical resistance**. This point is especially important to note, being the market of MEMS sensors one of the fastest growing markets of the last years (for example, the incorporation of MEMS sensors, such as accelerometers, gyroscopes, pressure sensors, into smartphones).

More over the use of Boron containing glasses (obtained from Boron trioxide) has been recently investigated as possible replacement material of Lead containing glasses.

A typical **time frame** for a substitution process in the semiconductor industry would be as described in fig 1

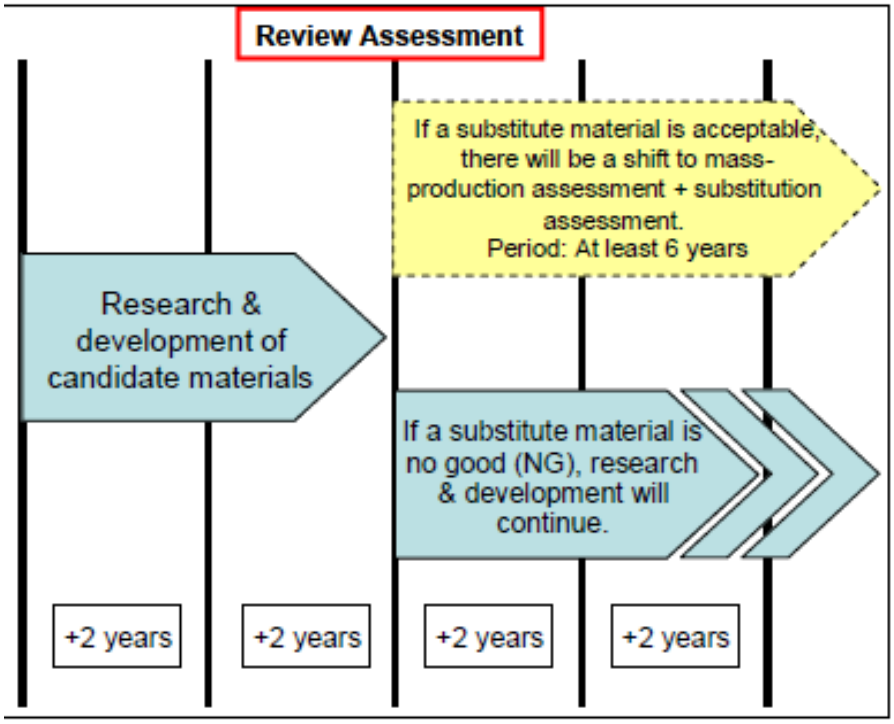


Figure 1

Assuming that after 2 years of new process trials, a suitable candidate is considered for the manufacturing of components and **positively qualified** (after almost 2 years), then the product is tested for acceptance by customers selected for the criticality of their applications (which will take about another 2 years). After the selected customers' acceptance, a **PCN** (product/process change notification) will be issued (high level classification) for **global customers' acceptance** and the mass production will start only after positive returns.

There is no clear visibility of a possible substitute availability and, therefore, of authorization needs in less than **4 years' timeframe.**

Although it is believed that **the use of frits in the specific application of MEMS manufacturing in the semiconductor industry is to be considered out of the scope of the authorization,** in case this position is not agreed upon, it would be suitable to have the latest application date **48 months after the Annex XIV publication date,** instead of the actual proposal of 24 months.