Typical Isolation Process Recommendation Using BoronPlus

Prepared For		**Source Type**	GS-245
Application	Isolation	**Part Number**	9241A
Sheet Resistivity After Predep	4 Ohms/Sq.	**Source Size**	100x2.0 mm
Junction After Predep		**Diffusion Tube ID**	155mm
		Preparation	JER1993

New sources may be cleaned and must be properly aged before they are used in testing or production. Refer to Aging for instructions. In this process, the sources should be aged at the recommended deposition temperature for at least 4 hours but no longer than 8 hours.

Deposition Cycle

Step	Rate/Time	Temp	Gas	Flow Rate
Insert	4"/Minute	750oC	N_2 + 1/2% O_2	6 lpm
Stabilize	8 Minutes	750oC	N_2 + 1/2% O_2	6 lpm
Ramp Hold	8°C/Minute	1100oC	N_2 + 1/2% O_2	6 lpm
Ramp	60 Minutes	1100oC	N_2 + 1/2% O_2	6 lpm
In-Situ	8°C/Minute	950oC	N_2 + 1/2% O_2	6 lpm
LTO	8°C/Minute	750oC	100% O_2	6 lpm
Pull	4"/Minute	RT	N_2 + 1/2% O_2	6 lpm

Caution: Any time BoronPlus sources are exposed to temperatures above 600°C, silicon wafers should be placed between each pair of sources and at each end of the load.

Special Instructions

SI 1

The gas flow rate recommended is based on experience with a variety of different systems. Some customers have found that increasing the gas flow rate during insertion and withdrawal will further decrease the chances of moisture backstreaming from the mouth of the furnace. This technique is particularly useful if only an end plate is used to cover the cap of the furnace, or if the end cap is loose fitting.

SI 2

Initially, the indicated percentage of oxygen should be mixed into the carrier gas. The purpose of oxygen is twofold: to prevent silicon surface damage and to oxidize the boron-silicon phase that forms between the deposited glass and the silicon wafer. We suggest increasing the oxygen concentration only if silicon surface damage is observed. Once

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an acceptable sheet resistivity is achieved, the oxygen concentration may be further increased for high temperature depositions to minimize the thickness of the boron-silicon phase.

Care should be taken to avoid using too much oxygen. Excessive oxygen will not only convert the boron-silicon phase to B2O3 and SiO2, but it will also oxidize the silicon surface. This thin oxide can mask off some of the boron resulting in non-uniform doping of the silicon.

The oxygen concentration should be high enough to eliminate silicon surface damage, and low enough not to cause non-uniform doping of the silicon. Remember that oxygen will not affect the BoronPlus sources.

SI 3

Variations in the humidity level of the plant air could cause variations in sheet resistivity. To reduce the effects of moisture, the following steps are recommended:

After predeposition, cool the silicon and sources in dry nitrogen When not in use, always store the sources in dry nitrogen at an elevated temperature

SI 4

Use of a high oxygen concentration during a portion of the cooling time from the deposition temperature oxidizes the boron-silicon phase. It also minimizes silicon damage often associated with the formation of the phase.

Diffusion Carrier Design

Ensure that the BoronPlus sources are loose in their slots. Tight slots can result in warped sources. Slot dimensions and carrier fabrication dimensions can be found in Product Bulletin Carrier Design. The BoronPlus™ and PhosPlus® sources have the same dimensions, permitting the same boat design to be used for both types of sources.

Cleaning

Cleaning BoronPlus sources is not normally necessary. If you want to clean them, the following procedures are recommended:

- Cleaning Procedures
- 8 minutes in NH4 OH/H202/H20(1/1/5) at 80°C or
- 8 minutes in a megasonic cleaning system at room temperature
- 2 minutes in DI WATER
- 10 minutes DRY at 90°C

The BoronPlus sources should not come in contact with HF or HCI at any time.

Oxidation of the B-Si Phase

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There are several techniques available for oxidizing any boron-silicon phase that has formed between the deposited boron glass and the silicon substrate. Listed below are the three most popular methods. You may select the approach best suited to your process.

- A high temperature oxidation process that involves changing from nitrogen to 100% oxygen at the predeposition temperature. While this technique can rapidly remove the boron-silicon skin, the oxidation rate is so high that it may also convert doped silicon to SiO2, resulting in back-diffusing of the boron from the silicon and in non-uniform doping of the silicon.
- Use a high oxygen concentration during some or all of the cooling time form the deposition temperature. this has been shown to work very well for high temperature processes. It not only oxidizes the boron-silicon phase, but it also minimizes silicon damage often associated with the formation of the phase.
- Deglazing the silicon wafers and then placing them back in the diffusion furnace for 2030 minutes at 800 - 900oC in steam. This technique is often preferred for base processes instead of the in-situ LTO described in (b) above because of the better sheet resistivity uniformity it normally provides. This process is commonly referred to as a low temperature oxidation (LTO) cycle.

Remember that BoronPlus sources are not sensitive to oxygen. You may, therefore, tailor the oxygen concentration in your carrier gas to produce the best results for your devices.

Aging

Before using BoronPlus sources in production for the first time, an initialization or aging period is required. This ensures that all moisture has been vaporized, and it enables the sources to achieve a constant rate of boron evolution. Aging should take place at the predeposition temperature in nitrogen with 25 - 50% oxygen. Aging may last from a few hours for high temperature processes to as long as 24 hours for low temperature processes. See Page 1 for the recommended aging time for this process.

Remember that BoronPlus sources are not sensitive to oxygen. You may, therefore, tailor the oxygen concentration in your carrier gas to produce the best results for your devices.

Caution: Any time BoronPlus sources are exposed to temperatures above 600°C, silicon wafers should be placed between each pair of sources and at each end of the load.

Storage

Appropriate storage procedures should be followed to protect BoronPlus sources from unnecessary exposure to moisture. Proper storage will contribute to increased uniformity and long life of the sources and will improve the electrical properties of your devices.

For dedicated diffusion tubes, we recommend that BoronPlus sources be stored in the hot zone of the tube near 600oC. Sufficient dry nitrogen should flow through the tube so that no backstreaming will reach the sources. In those cases where the diffusion furnace is used for other processing steps, or is somehow not suitable for storing

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BoronPlus sources, the BoronPlus sources should be stored in an oven at a temperature above about 200oC. The oven must be continuously purged with dry nitrogen flowing at a rate sufficient to prevent room air from entering the storage chamber.

When the sources are stored in room air or accidentally left in room air for a considerable period of time, sufficient moisture may be absorbed to affect their performance during the following run. Their performance can be easily restored, however, by inserting the sources into the diffusion tube at the insertion temperature for about 15 minutes. When they are withdrawn from the tube, the boat is ready for loading with production silicon.

References

1. J. E. Rapp, The Planar Diffusion Technique, Semicon Technology Asia 1998/9, Nordica International.3.F Block B, Quarry Bay, Hong Kong, p. 33.

2. R. Rogenski, The In-situ Low Temperature Oxidation Processing Step, Global Semiconductor 2000, Sterling Publications Limited, London, England, p. 29.

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