Revision #3, June 1998

BORON-A

SEMICONDUCTOR SPIN-ON DIFFUSANT

GENERAL DATA

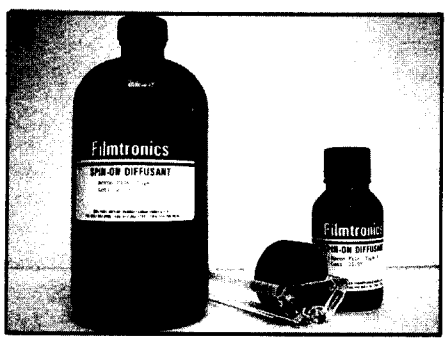
Boron-A consists of boron compounds in an organic solution. It provides excellent diffusion uniformity with average deviations in sheet resistance below 5% from run to run, below 2% with a diffusion of 50 wafers in a carrier, and below 2% across a 100mm wafer. Boron-A eliminates surface damage to silicon during diffusion.

Boron-A can be used for a variety of diffusions such as discrete transistors, rectifiers, power devices, bipolar IC bases isolation diffusions, source and drain regions in p-channel MOS and CMOS p-well diffusions.

ADVANTAGES OF BORON-A

- Consistent coating of silicon substrate for any diameter silicon wafer.
- Improved yields, as diffusion is not dependent on flow patterns of gas or ambient composition.
- Boron-A is hydrophobic, therefore application is unaffected by humidity when applied to substrate prior to diffusion.
- Application may be with automated spin-on equipment.
- No boron source wafers are needed, therefore your diffusion equipment is used to its full potential with a greater density of wafers diffused.
- No sticking of boron source wafers to quartzware, reducing time to clean quartzware.
- No storage of boron source wafers at elevated temperatures.
- Boron-A may be stored at room temperature; refrigeration is not necessary. Shelf life is at least 5 months.
- Low cost as a small amount of Boron-A is used per wafer; approximately 1ml per 4" wafer.
- No pre-bake of coated silicon slice.
- No staining or damage of silicon.
- High purity source.

Si	0.01 PPM	Na	0.01 PPM
Mn	0.01 PPM	Cu	0.01 PPM
K	0.01 PPM	Ni	0.01 PPM
Fe	0.01 PPM	Cr	0.01 PPM



APPLICATIONS OF BORON-A

Wafers are prepared for coating by use of standard cleaning methods. NH_4OH-H_2O_2, H_2SO_4-H_2O_2, dilute HF dips, followed by rinses and spin-dry to yield a clean surface.

Boron-A is then applied to the silicon slice and spun using a teflon or delrin chuck for 20 seconds at D x 1000 rpm where D = silicon diameter in inches. Use approximately 0.5 to 1.0 ml on a 2 inch slice, 1.0 to 2.0 ml for a 4 inch slice. Wafers may then be placed directly into the diffusion boat as a pre-bake is not necessary. A quartz "V" boat or oxidation boat with 0.1 inch spacing works well. Wafers should be placed perpendicular to the gas flow the diffusion tube with 3 to 5 coated dummy slices at each end of the boat. Deviation in sheet resistance is reduced about 1% by placing coated sides facing each other. Diffusion boats containing coated wafers may be kept in a clean environment at room conditions for up to 10 hours before being placed in the diffusion furnace. When spinning, accelerate and decelerate spinner as fast as possible.

Exhaust on an automatic coater is important. If spin thickness or uniformity problems are noticed, generally exhaust is set too high.

Undiffused boron coatings on silicon or spin-on equipment may be cleaned with isopropanol.

DIFFUSION

It is important to use a clean tube that is free from water vapor. Dry gases should be used and the diffusion tube should be flushed with dry gases prior to diffusion.

The recommended gas for diffusion is 97% nitrogen with 3% oxygen, however this may be varied.

Flow rates of gas are dependent on wafer diameter and tube diameter. A recommended gas flow rate for a four inch tube with 2.5 inch to 3 inch wafers is 1.5 lpm. For a 5 inch diameter tube with 3 inch to 4 inch wafers, 2.5 liters per minute is appropriate.

After diffusion, wafer may be cleaned in 10% HF solution.

DIFFUSION DATA

A diffusion of 900°C for 45 minutes in N_2 with Boron-A applied at 3000 rpm yields a sheet resistance at 125 ohms per square.

A TWO STEP DIFFUSION FOR BIPOLAR BASE

Wafers are coated and a deposition of boron is conducted at temperatures mentioned below. After deposition, wafers are deglazed in 10% HF for three minutes. Sheet resistance measurements taken on 10 ohm-cm silicon slices were as follows:

TIME	TEMPERATURE	JUNCTION DEPTH	SHEET RESISTANCE
60 min.	850°C	0.09 micron	210-225
60 min.	900°C	0.2 micron	90-95
60 min.	930°C	0.25 micron	54-58
60 min.	950°C	0.4 micron	40-45
60 min.	1000°C	1.1 micron	19-23
60 min	1100°C	2.5 micron	4.8-5.1
60 min.	1200°C	6.3 micron	2.0-2.5

After the deposition and deglazing previously mentioned, it is advantageous to remove the boron silicide remaining on the silicon surface. This layer is detected by the absence of "water break" on the slice after HF deglaze. To remove this layer, a 20 to 30 minute wet oxidation is suggested at a temperature of approximately 750°C. The deposition step may be shortened and the removal of boron silicide may be avoided, but there is a greater chance of surface damage if you complete the sequence without removal of boron silicide. Boron-A is also available in more dilute form — 25% and 50% dilutions.

At the end of the oxidation, the furnace is ramped to the desired diffusion temperature and drive-in is effected. Any mixture of oxygen, steam or nitrogen may be used to yield the appropriate junction depth, concentration and thickness of oxide needed.

— SEE REVERSE SIDE —

FILMTRONICS
SEMICONDUCTOR PROCESS MATERIALS

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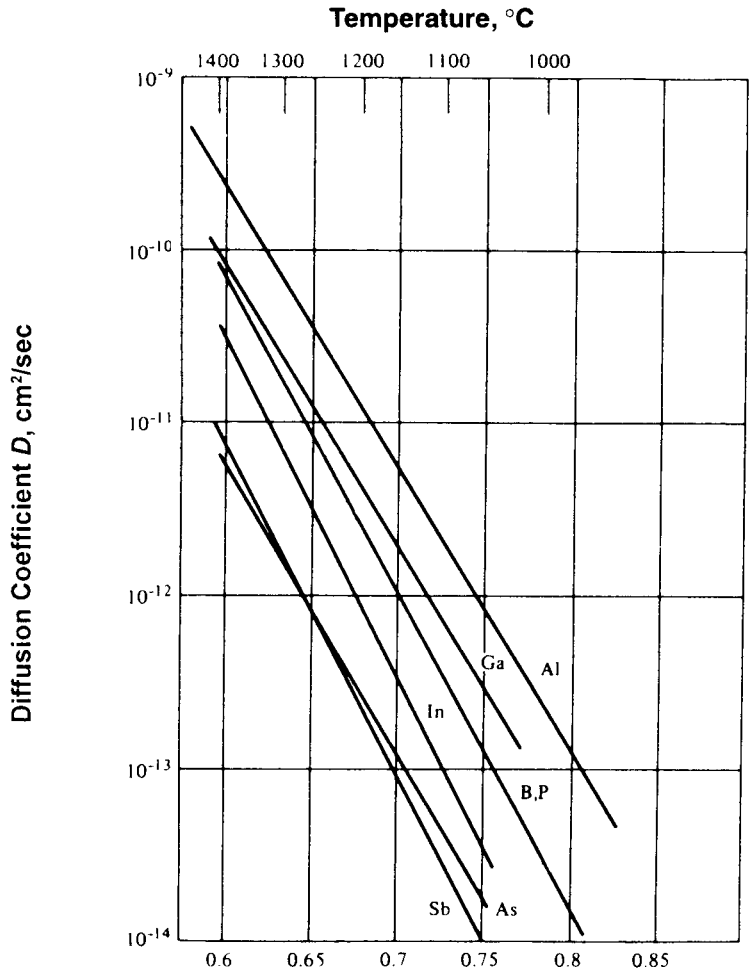
ONE STEP DIFFUSION OF BIPOLAR ISOLATION

Wafers are coated as mentioned previously and are slowly introduced into the hot zone of the furnace at diffusion temperature. Alternatively, wafers could be pushed into the furnace at 875°C and the temperature ramped up.

Diffusion is 30 minutes in dry nitrogen with 1% oxygen at appropriate temperature. After 30 minutes, any mixture of oxygen, nitrogen and steam may be used to achieve the desired sheet resistance, oxide thickness and junction depth.

After diffusion, wafers are deglazed in 10% HF. Some diffusion data for particular times and temperatures follow for 10 ohm-cm silicon with the previously mentioned procedures completed in dry 99% N_2 with 1% O_2.

TIME	TEMPERATURE	JUNCTION DEPTH	SHEET RESISTANCE AVERAGE
15 min.	900°C	0.12 micron	150
30 min.	1000°C	0.9 micron	30
60 min.	1100°C	2.8 micron	5.0
360 min.	1100°C	5.7 micron	2.9
30 min.	1145°C	3.0 micron	3.8
60 min.	1145°C	3.3 micron	2.9
180 min.	1200°C	6.1 micron	2.5



Diffusion coefficients of various dopants in silicon.

PACKAGING

Boron-A is available in 125ml (4oz.) and 1000ml (32oz.) containers. Prices are available upon request. Boron-A is also available in a more dilute form; 25% reduction and 50% reduction.

SAFETY NOTES

When using automated spin-on equipment, we suggest using tubing such as teflon. Polypropylene or polyethylene may deteriorate. Boron-A contains an organic solvent and should be used in a well ventilated area. Skin contact should be avoided. If accidentally contacted and material is washed off promptly, little or no irritation should result. Eye contact should be treated as contact with any corrosive agent and should be treated immediately. Boron-A is toxic by ingestion. Personnel using this material should be advised of the toxic nature and should be trained in the handling of toxic materials.