PDS® Products Phosphorus N-Type Source Wafers

PDS Products Technical Data

Overview

PDS Products Phosphorus source wafers offer low cost, in-situ, n-type planar sources for silicon diffusions. In-situ PDS Products eliminate the trade-off between throughput and uniformity for larger diameter wafers. All grades of N-type PDS Products are manufactured in diameters up to 200 mm.

Grade and Performance

Grade	Temperature Range	Sheet Resistance Range
PH-900	825 – 900 °C	15 - 150 Ω/□
PH-950	875 – 950 °C	60 - 5 Ω/□
PH-1000N	925 -1000 °C	25 - 3 Ω/□
PH-1025	975 -1025 °C	25 - 3 Ω/□

Use of PDS Products enables the user to change source wafer diameter with little or no change in the diffusion process.

Typical Applications include:

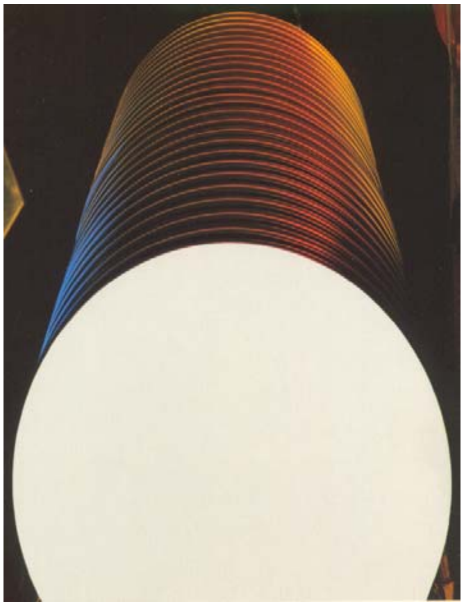
- Emitter
- Collector
- Backside gettering
- Enhancement
- Source/drain
- Sinker
- Polysilicon doping
- Solar cell

For all applications, Saint-Gobain Advanced Ceramics Boron Nitride offers unparalleled technical guidance based on over 45 years of experience in diffusion technology.

Source Composition

All N-type PDS Products consist of an active component Cerium Pentaphosphate (CeP_5O_{14}) or Silicon Pyrophosphate (SiP_2O_7) carried on and in an inert porous Silicon Carbide (SiC) substrate

Grade	Active Component
PH-900	100% CeP_5O_{14}
PH-950	100% SiP_2O_7
PH-1000N	100% SiP_2O_7
PH-1025	60% ZrP_2O_7 30% SiP_2O_7 10% SiO_2



Advantages of PDS Products

- Extreme flexibility that allows application to many device structures, thereby eliminating capital expense in device conversion.
- Improved yields by gettering oxidation induced stacking faults and improved uniformity across the wafer, across a run and from run-to-run.
- Precision chemical principles make for predictability and repeatability through the controlled introduction of moisture in the diffusion tube, even at temperatures as low as 825°C.
- A trained staff is maintained to assist in all technical needs and support.

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At diffusion temperature, the active component decomposes to form P_2O_5 vapor, which evolves from the source by direct volatilization. The by-product of the decomposition remains on the source wafer.

Active Component	Dopant Vapor	By-Product
Cerium Pentaphosphate (CeP_5O_{14})	P_2O_5	CeP_3O_9
Silicon Pyrophosphate (SiP_2O_7)	P_2O_5	SiO_2

Source Use

Stacking Arrangement*

PDS Products and silicon wafers are edge-stacked perpendicular to the tube axis in cross-slotted furnace carriers.

Gases and Flow Rates*

During the evaluation phase of PDS Products, a full boatload of dummy silicon wafers is needed to create the boundary layer condition and achieve meaningful results. Typical total gas flow rates are 6 – 10 slpm, depending on the combination of source wafer and process tube diameters used. Optimization of across the wafer and across the boat diffusion parameter uniformity may require that these flow rates be modified.

Source Preparation

Wet chemical cleaning is unnecessary since the sources are manufactured under the most exacting quality standards using raw materials of the highest purity, and are protected from exposure to contaminants both during and after manufacture. Furthermore, due to the porosity of the composition, cleaning agents are difficult to remove completely.

It is recommended that prior to actual product silicon diffusion, new phosphorus source wafers be annealed at the following temperatures in an ambient of 100% N2:

PH-900: 925°C for sixteen hours

PH-950: 900°- 950 °C for eight hours

PH-1000N: 950°-1000°C for eight hours

PH-1025: 1000°-1025 °C for four hours

* See Technical Bulletin “Furnace Carriers for PDS Products in Diffusion Processing”

Diffusion Process Outline

Step	Ambient	Time	Function
Push in & Recovery	N_2 (100%)	15 Min.	Thermal Equilibrium
Soak	N_2 (100%)	Variable	Resistivity Target
Deglaze	10:1 HF	2 Min	Remove Unreduced Glass

Push in and Recovery

During the recovery step, source boats stacked with Phosphorus and silicon wafers are pushed into a diffusion tube. The tube is then allowed to establish ambient equilibrium. This step is performed in an ambient of 100% N_2 at 750°C-850°C. Typical total gas flow rates are 6–10 slpm, depending on the combination of source wafer and process tube diameters used.

Soak

During the soak step, the dopant, glass which is uniformly coating the silicon wafers undergoes a reduction reaction in the ambient which results in the formation SiO2 and phosphorus

Deglaze

After the Si wafers are unloaded from the furnace, the excess un-reacted dopant glass is removed by 10 parts DiH2O to 1 Part HF for 2 minutes at room temperature.

Storage

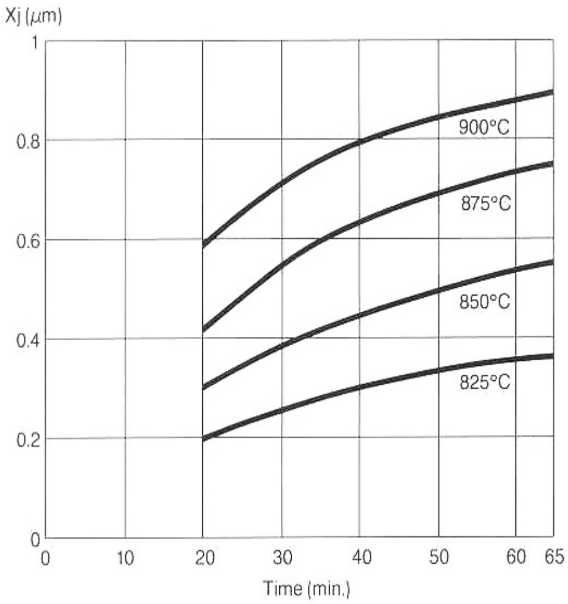
Optimum source wafer storage between uses is in dry N_2 at 400°C. Storage in the mouth of the diffusion tube is not recommended.

Furnace Loading and Unloading Cycles

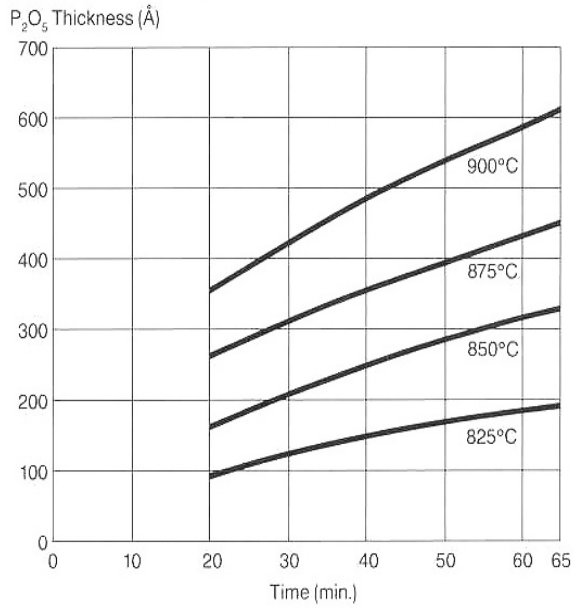
A slow push during furnace loading (typically 5.0”/ min.) at 700°- 800°C is advised. The boats should be allowed to equilibrate for 5-10 min. under N2 before ramping to use temperature. A subsequent ramp down to 700°- 800°C before unloading is also recommended.

PH-900:

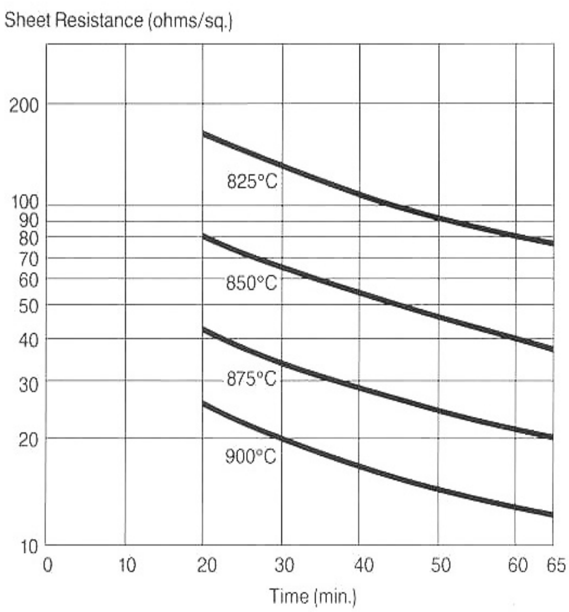
Junction Depth vs. Deposition Time



P_2O_5 Glass Thickness vs. Deposition Time



Sheet Resistance vs. Deposition Time



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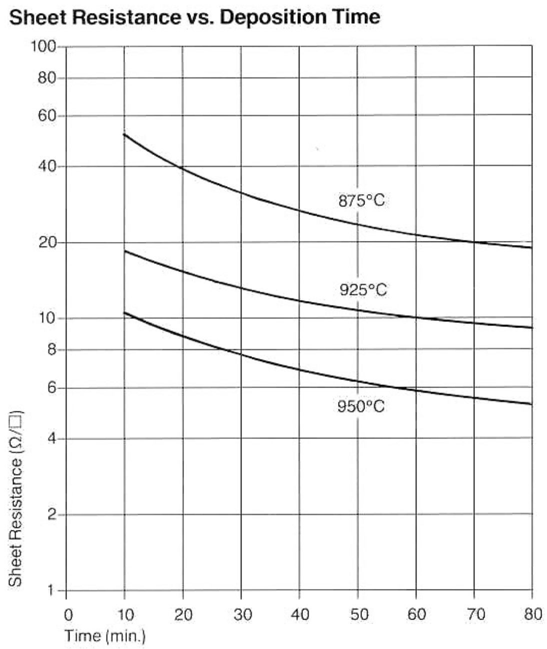
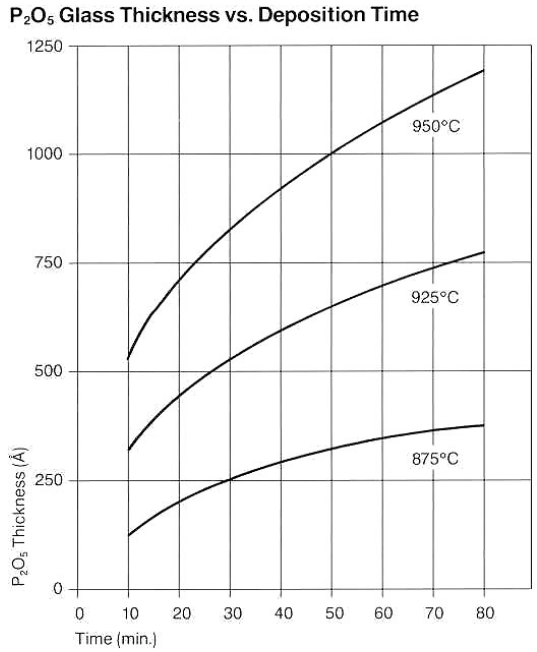
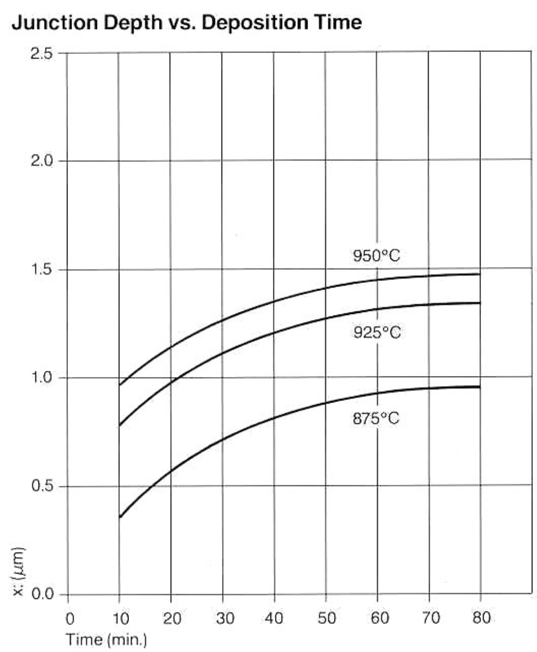


Sheet Resistance vs. Deposition Time
100
80
60
40
20
10
8
6
4
2
1
875°C
925°C
950°C
Sheet Resistance (Ω/□)
0
10
20
30
40
50
60
70
80
Time (min.)



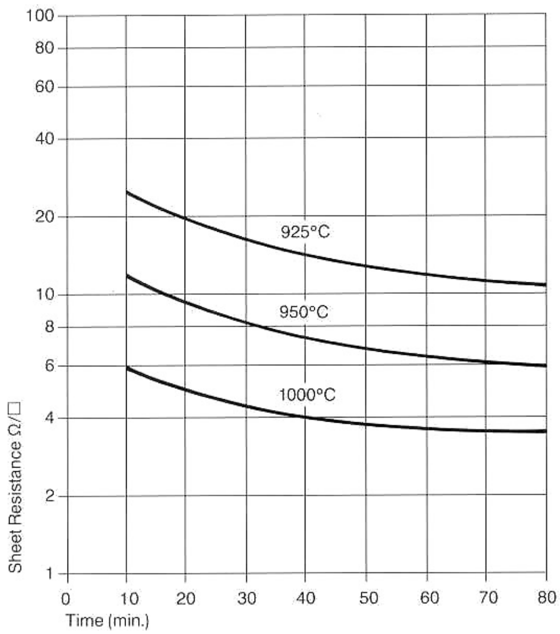
P_2O_5 Glass Thickness vs. Deposition Time
1250
1000
750
500
250
0
950°C
925°C
875°C
P_2O_5 Thickness (Å)
0
10
20
30
40
50
60
70
80
Time (min.)



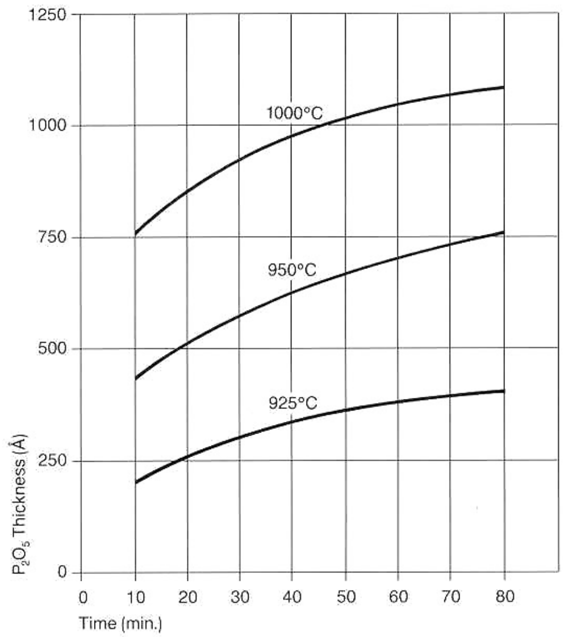
Junction Depth vs. Deposition Time
2.5
2.0
1.5
1.0
0.5
0.0
950°C
925°C
875°C
x: (μm)
0
10
20
30
40
50
60
70
80
Time (min.)

PH-1000N:

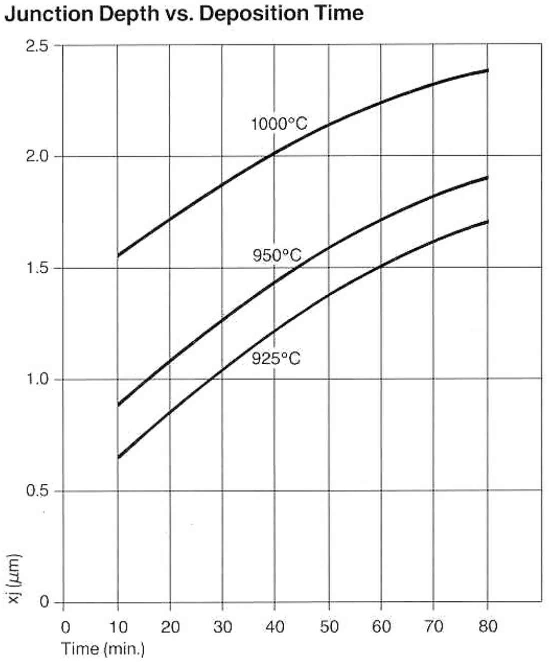
Sheet Resistance vs. Deposition Time



P_2O_5 Glass Thickness vs. Deposition Time



Junction Depth vs. Deposition Time



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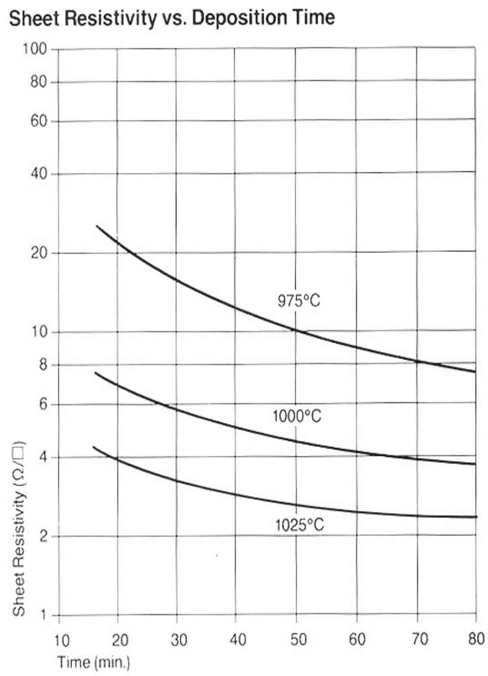

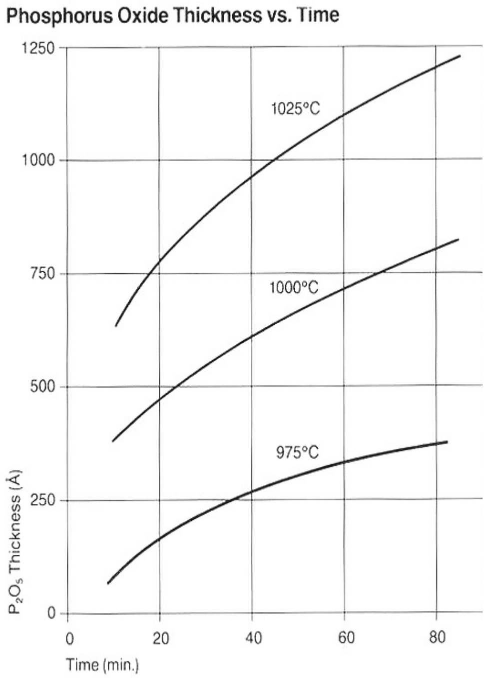

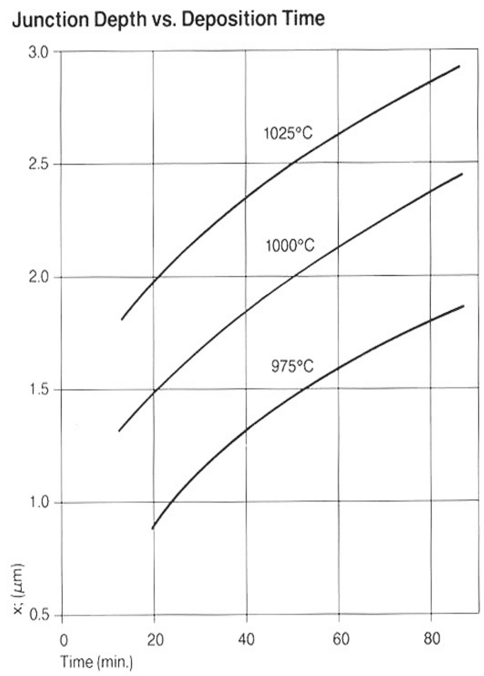

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Effective 9/02 Printed in the USA.

Document # bnpdstechdoc3 Rev. A