PDS® Products

N-Type Planar Diffusion Sources

PRODUCT DATA SHEET

N-Type Diffusion Source Wafers for the Semiconductor Industry

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 available in diameters up to 200 mm. Use of PDS Products enables the user to change source wafer diameter with little or no change in the diffusion process.

AVAILABLE GRADES AND TYPICAL PROPERTIES

N-type PDS Products are mechanically stable, solid diffusion source wafers that combine phosphorus and an inert silicon carbide substrate.

All N-type PDS Products consist of an active component Cerium Pentaphosphate (CeP5O14) or Silicon Pyrophosphate (SiP2O7) carried on an inert porous Silicon Carbide (SiC) substrate. At diffusion temperature, the active component decomposes to form P2O5 vapor, which evolves from the source by direct volatilization. The by-product of the decomposition (CeP3O9 or SiO2) remains on the source wafer.

Grade	PH-900	PH-950	PH-1000N	PH-1025
Composition	100% CeP5O14	100% SiP_2O_7	100% SiP_2O_7	60% ZrP_2O_7 30%SiP_2O_7 10% SiO_2
Temp °C	825-900	875-950	925-1000	975-1025
Sheet Resistance (Ohm/Sq)	150-15	60-5	25-3	25-3
Phosphorus Glass Thickness Å	100-650	125-1200	175-1200	100-1250
Dose atoms / cm^2	1.4×10^{14} to 3.9×10^{15}	3.2×10^{14} to 2.4×10^{15}	8.4×10^{14} to 1.1×10^{16}	5.3×10^{15} to 1.4×10^{16}

STACKING ARRANGEMENT

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

Features/Benefits

- 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.
- Moisture modulation of the vapor pressure of the B_2O_3- HBO_2 system causes a rapid flux of gas, creating excellent uniformity and allowing a damage control mechanism to be established simultaneous to the deposition process.
- A trained staff is maintained to assist in all technical needs and support.

Key Applications

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

Target Markets

- Semiconductor manufacturing
- Microelectro-mechanical systems (MEMS)

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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% N_2:

PH-900	PH-950	PH-1000N	PH-1025
925°C	900°-950°C	950°-1000°C	1000°-1025°C
for 16 Hrs	for 8 Hrs	for 8 Hrs	for 4 Hrs

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

1. **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.

2. **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 SiO_2 and phosphorus.

3. **Deglaze:** After the Si wafers are unloaded from the furnace, the excess un-reacted dopant glass is removed by 10 parts DiH_2O 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 N_2 before ramping to use temperature. A subsequent ramp down to 700°-800°C before unloading is also recommended.

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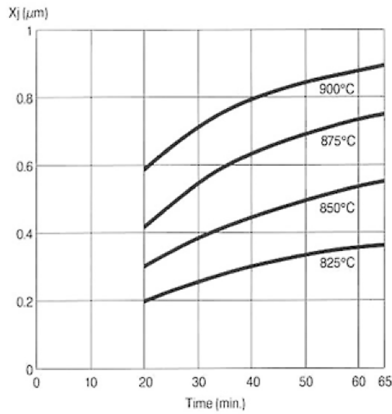
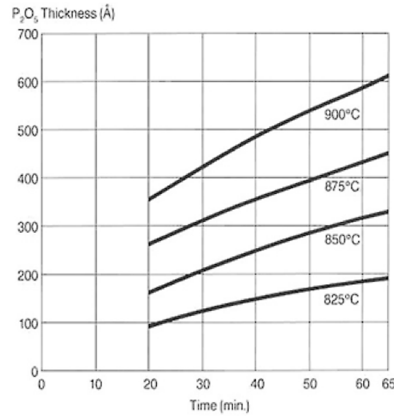
PERFORMANCE DATA: PDS PRODUCTS N-TYPE GRADE PH-900

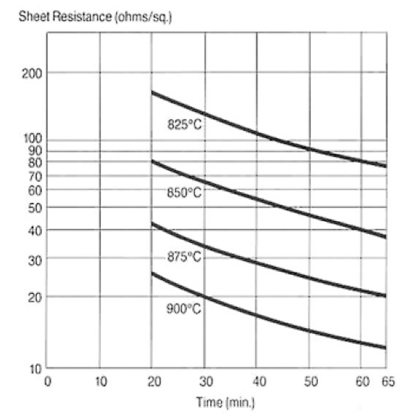
Junction Depth vs. Deposition Time



P_2O_5 Glass Thickness vs. Deposition Time

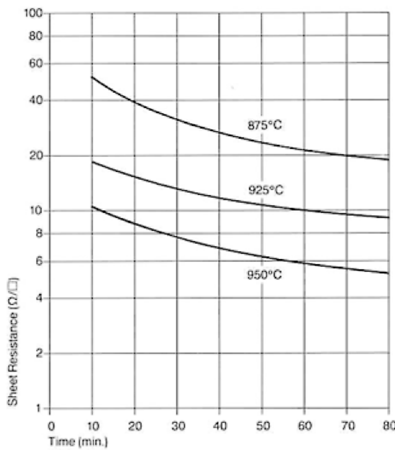


Sheet Resistance vs. Deposition Time

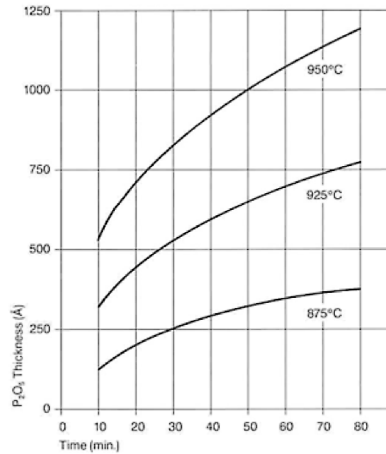


PERFORMANCE DATA: PDS PRODUCTS N-TYPE GRADE PH-950

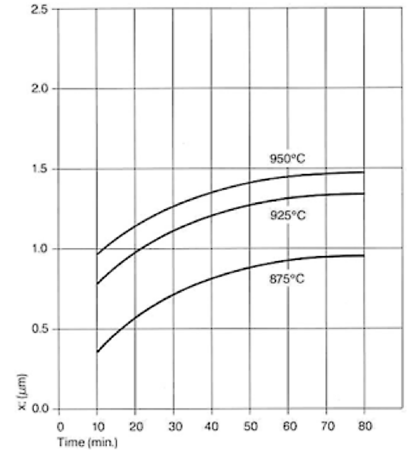
Sheet Resistance vs. Deposition Time



P_2O_5 Glass Thickness vs. Deposition Time

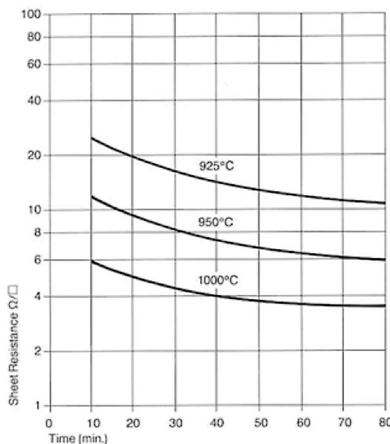


Junction Depth vs. Deposition Time

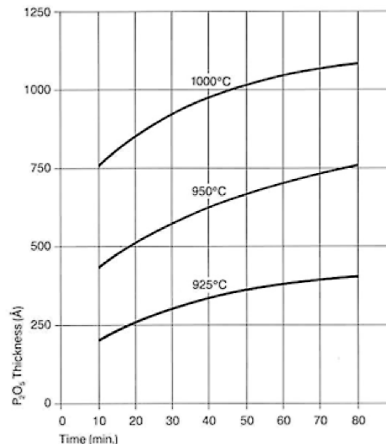


PERFORMANCE DATA PDS PRODUCTS N-TYPE GRADE PH-1000N

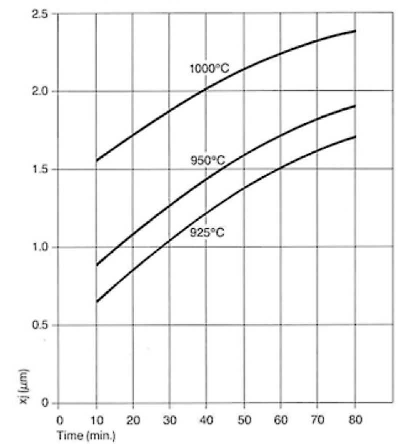
Sheet Resistance vs. Deposition Time



P_2O_5 Glass Thickness vs. Deposition Time



Junction Depth vs. Deposition Time



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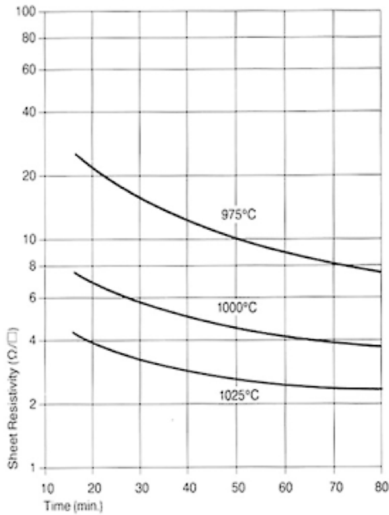
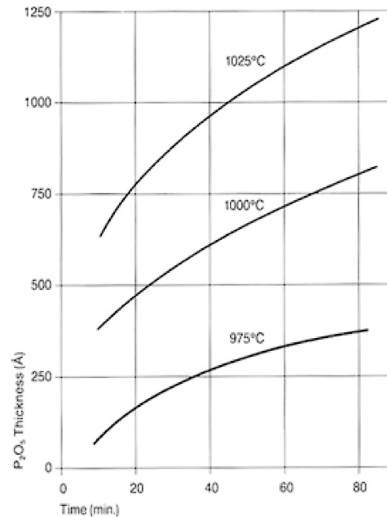
PERFORMANCE DATA: PDS PRODUCTS N-TYPE GRADE PH-1025

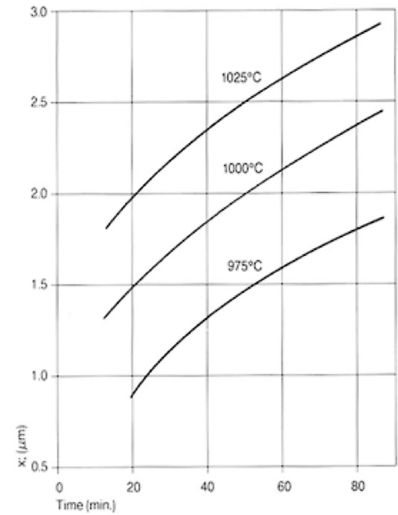
Sheet Resistivity vs. Deposition Time



Phosphorus Oxide Thickness vs. Time



Junction Depth vs. Deposition Time



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