

Diffusion Carrier Design

Introduction

The BoronPlus and PhosPlus sources change dimensions when they are inserted into the diffusion furnace because of their thermal expansion coefficients. These dimensional changes could cause the sources to be damaged during use if the diffusion carrier or boat in which they have been placed is not designed properly. This bulletin therefore provides the diffusion engineer with the appropriate guidelines necessary for him to prepare acceptable boats for his diffusion system. The BoronPlus and PhosPlus sources use the same boat design.

Boat Designs

Diffusion boats of various designs have been successfully used with BoronPlus and PhosPlus sources. Since quartz boats tend to deform at high temperatures, polysilicon or silicon carbide boats are often used above 1100°C.

Figure 1 shows a typical boat which holds 27 sources and is designed for manual push/pull systems. Longer boats which hold more sources can be used, but they become quite heavy when fully loaded making them difficult to handle and difficult to push in and pull out of the diffusion furnace.

Figure 1

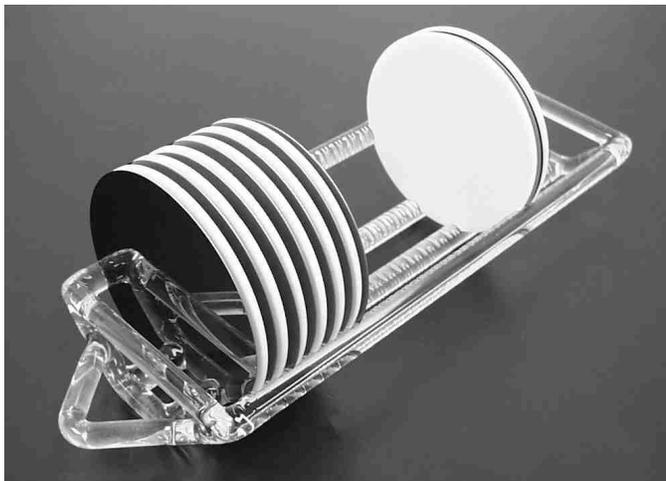


Figure 2 is a picture of a four-rail boat designed for automatic transfer systems. These boats usually hold 13 sources and fit end-to-end on standard paddles and cantilever systems. Since boats that fit on automatic transfer systems also require specific external dimensions, the diffusion engineer should contact the manufacturer of his transfer equipment to obtain the specific boat design details.

Figure 2



Critical Boat Dimensions

Dimensions that are of particular concern when designing a carrier for the BoronPlus or PhosPlus sources are the diameter and width of the slot for the source and the distance between the silicon surface and the source surface. These dimensions are given in Table I for sources ranging from 2" to 150mm in diameter.

Generally the width of the slots for the sources should be about 0.010" (.25mm) wider than their thickness. The sources should fit loosely in the boat, allowing room for expansion of at least 0.020" (0.5mm) per inch of diameter. Also, the boats are normally designed so that the spacing between the silicon surface and the source surface is 0.100" (2.5mm). Since some automatic transfer systems require a closer spacing than this because of the thickness of the BoronPlus and PhosPlus sources, the dimension can be decreased to as low as 0.060" (1.5mm). Whatever spacing is selected, however, it should remain constant across the boat.

Conclusion

The diffusion engineer must ultimately choose the appropriate materials and boat design for his specific application. This bulletin contains information to assist him in making the correct choices.

Table I. Boat Dimensions

Source:							Notes
A Diameter	2"	3"	100mm	125mm	150mm		
B Thickness	.060"	.060"	2mm	2.5mm	3.0mm		
Silicon:							
C Diameter	2"	3"	100mm	125mm	150mm		
D Thickness	.016"	.020"	.5mm	.6mm	.65mm		(1)
Silicon-Source Spacing:							
E Center/Center	.138"	.142"	3.75mm	4.05mm	4.30mm		(1)
F Surf/Surf	.100"	.100"	2.5mm	2.5mm	2.5mm		(2)
Silicon-Silicon Spacing:							
G Center/Center	.080	.080"	2.0mm	2.0mm	2.0mm		(3)
H Surf/Surf	.064	.060"	1.5mm	1.4mm	1.4mm		(1),(3)
Slot Dimensions:							
I Source Diam.	2.040"	3.060"	102.0mm	127.5mm	153.0mm		
J Source Width	.070"	.070"	2.25mm	2.75mm	3.25mm		(4)
K Silicon Diam.							(1)
L Silicon Width							(1),(3)
Boat Dimensions:							(5)
M Width							
N Height							
O Length							
Rod Diameters:							
P Slotted Rails	8mm	9mm	9mm	9-12mm	9-12mm		
Q Support Rails	6mm	6mm	8mm	8-9mm	8-9mm		

Notes:

(1) These dimensions must be appropriately modified if silicon wafers of a different thickness are to be doped.

(2) The 0.100" (2.5mm) spacing is recommended for most applications. The distance can be decreased if it is desired to increase the boat capacity, to use the boat in automatic transfer systems, etc.

(3) Distance "G" can be reduced to the thickness of one silicon wafer, "D", if silicon wafers are to be loaded back-to-back and if they are to be placed into one slot in the boat. In this case there would be no distance "H" and dimension "L" would be increased by "D" to accommodate the two silicon wafers. Additional adjustments in these three dimensions would also have to be made if only one silicon wafer is placed between two sources for the purpose of simultaneously doping both surfaces.

(4) These dimensions are recommended for low profile boats and for boats that are to be used in automatic transfer systems. If the boats are to be manually loaded, the slotted side rails could be raised to the center line of the source diameter (three o'clock and nine o'clock positions) and the slots could be increased by up to 0.010" (0.25mm).

(5) The boat dimensions will be determined by various equipment and processing requirements such as the number of silicon to be processed, the length of the hot zone of the diffusion furnace, whether or not the boats are to be placed in cantilevers or sleds or if they are to be used in automatic transfer systems, etc.

For more information on this Product Bulletin or on the BoronPlus and PhosPlus dopant sources, contact the Planar Dopants Team: www.techneglas.com

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