Moisture-Enhanced Evolution Rate Process Using GS-126 BoronPlus® Sources

Introduction

The GS-126 p-type boron planar dopant source exhibits all of the desirable properties of the other BoronPlus sources. However, this source is specifically designed to be used at temperatures below 1000°C, with or without low levels of moisture being present in the nitrogen carrier gas.

How the process works

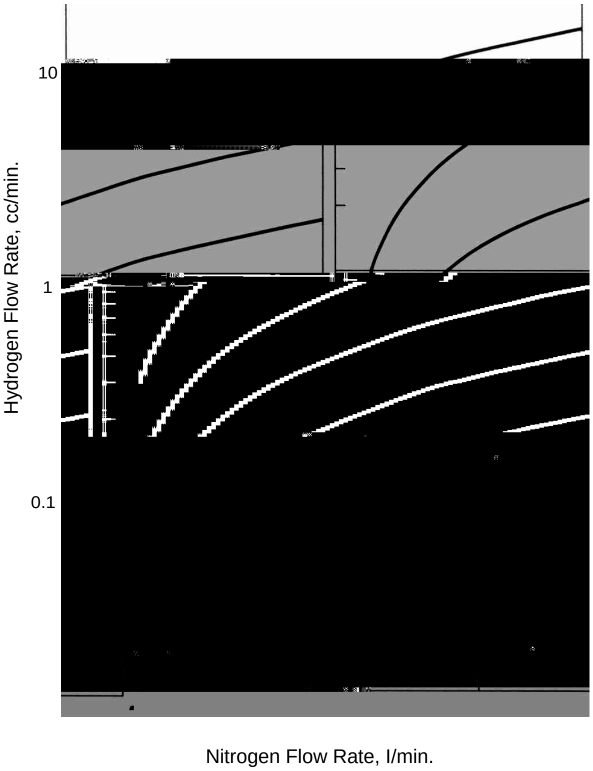
GS-126 sources uniformly deposit thin glassy films on the silicon wafers when used with conventional processing techniques in dry nitrogen. However, film thicknesses can be significantly increased if depositions are made in nitrogen containing controlled amounts of hydrogen and oxygen. When these gases are blended into the carrier gas, the hydrogen combines first with the oxygen to form H_20 which then reacts with B_2O_3 to form $HB0_2$. Since HBO_2 exhibits a much higher vapor pressure than B_2O_3, HBO_2 evolves from the source at a significantly higher rate than B_2O_3 and produces a thicker glassy film on the silicon wafer.

The thicker glassy films help to improve the uniformity of doping at low temperatures and tend to produce an increase in the thickness of the boron-silicon phase that forms under the deposited glass. When the silicon wafers are deglazed and given a low temperature oxidation cycle, most of the silicon surface damage is removed with the oxidized boron-silicon phase.

Required Equipment

Small quantities of hydrogen and oxygen can be easily and accurately blended into the nitrogen carrier gas in a production environment by using a mass flow controller system. An oxygen concentration of 500 ppm should be maintained for all depositions made between 850° and 900°C. The hydrogen flow rate is then used to control the theoretical moisture concentration forming in the diffusion tube.

Figure 1 shows the hydrogen flow rates theoretically required to create various moisture levels in nitrogen. To accurately control these low hydrogen flow rates, use of preblended hydrogen in nitrogen is recommended. The flow rates are low enough that one standard tank can be used for hundreds of runs. Table 1 gives typical flow rates for various hydrogen/nitrogen mixtures when nitrogen is flowing at 3 liters per minute. Proportional adjustments to these flow rates can be made for other nitrogen flow rates.



H_20	$10\%H_2, 90\%N_2$	$5\%H_2, 95\%N_2$	$1\%H_2, 99\%N_2$
15 ppm			

Deposition Cycle

A typical deposition cycle is schematically represented in Figure 2.

Figure 2
Typical Moisture-Enhanced Deposition Cycle

Table II shows maximum moisture levels recommended for depositions made at 850° and 900°C. Since higher levels exceed the rate at which the source can evolve HBO_2 they do not produce thicker glassy films.

800°C	30 ppm
900°C	120 ppm

Effect of Moisture on Boron Depositions

Figures 3 and 4 show the deposited glassy film thickness as a function of theoretical moisture content forming in the diffusion tube at 850°C and 900°C using the deposition cycle shown in Figure 2. These figures also show resulting sheet resistivity in the silicon under the deposited glass.