A high gas flow rate, however, is not very effective in preventing backstreaming in large diameter diffusion tubes (i.e., 200 mm). It has been reported that the nitrogen tends to flow to the top of the tube and the air tends to backstream down the bottom of the tube, regardless of the flow rate. Consequently, sufficient time should be allowed at the insertion temperature after the tube is closed so that the nitrogen can purge the tube of backstreamed air before ramping to the deposition temperature. Also, since cantilever systems are usually used with large diameter tubes, care should be taken to ensure all excess areas in the end cap around the cantilever arms are closed.

Gas Type

Most diffusion systems use nitrogen as the carrier gas in the diffusion tube. Some diffusion engineers prefer to use argon gas when depositions are to be made above about 1050°C because argon is an inert gas and does not react with the silicon surface to cause nitride pitting.

Gas Composition

The proper use of oxygen with the selected carrier

Some phosphorus emitter diffusion processes done with gas-type dopant sources often include an oxidation of the silicon surface immediately following the phosphorus deposition. This can also be done with the PhosPlus solid source system if the oxidation is done with dry oxygen. Dry oxygen can be used with the PhosPlus sources at any temperature since oxygen has no effect on the sources. However, the oxidation cannot be done at the deposition temperature with wet oxygen or with steam since the moisture will quickly deplete the PhosPlus sources of available P_2O_5 .

Removal of Boron Silicide Using LTO Cycles:

Boron silicide is the thin, metallic compound that forms under the deposited glassy film during a boron deposition cycle. Synonymous names are boron-rich phase, boron-silicon phase and silicon stain. The phase is insoluble in HF, and it can be detected after the HF etch by the hydrophilic (wetting) silicon surface compared to the normal hydrophobic (non-wetting) surface of undoped silicon wafers.

Boron silicide is beneficial to silicon processing because it produces uniform sheet resistivities in the doped silicon slices and because it can be used as a limited source of boron in certain drive cycles. However, this phase is removed most of the time before subsequent processing steps are taken so that it does not become a source of additional problems later.

The Traditional LTO Cycle: The most common method of removing the boron silicide phase is to use the low temperature oxidation (LTO) cycle. This technique involves stripping the glass from the doped silicon slices and then re-inserting them into the diffusion furnace without the sources being present. Holding the silicon slices at 800°C for 20-30 min in steam or in wet oxygen is usually sufficient time to oxidize a thin layer of this phase. The new oxide layer is then etched off the silicon surface in dilute HF before continuing the processing of the silicon wafers. The LTO cycle tends to raise the sheet resistivity, but it does not normally destroy the uniformity of the doped silicon slices.

The In-situ LTO Cycle: An important variation of the above LTO cycle that can be used in the presence of the BoronPlus sources is to start oxidizing the silicon with pure oxygen either during the cool-down portion of the deposition cycle or after the boat has reached the removal temperature [1]. Fig. 3 shows schematically how the in-situ LTO eliminates a processing step during a boron deposition cycle.

Although cooling in oxygen has eliminated the need for