



# 1986

## Vertical furnaces

~ Discrete Semiconductor/Others ~

Horizontal furnaces were used for oxidation, annealing, LP-CVD, and other processes. It was an isothermal furnace in which 100 to 150 wafers arranged vertically on a horizontal quartz boat were slid into a cylindrical quartz reaction tube. The entire quartz tube was heated by a heater. In this method, particle generation was inevitable while sliding a quartz boat into a quartz tube because of rubbing between the boat and the quartz tube. The method of placing the boat in the quartz tube after boat insertion using a cantilever was adopted, but the frequency of boat and quartz tube replacement was high due to deflection and deformation of quartz under high temperatures. As miniaturization of device pattern proceeded and wafer diameters increased, the generation of microscopic particles also became a problem. The growth of natural oxide film also began to impede miniaturization due to air contamination during boat insertion period. The vertical furnace was appeared to deal with these problems, in which the quartz reaction tube was placed vertically and a boat supporting the wafers horizontally was inserted from bottom of the tube.

The vertical furnace concept was derived from a floating zone crystal growth furnace for high-purity Si single crystal growth. There was an example applied for oxidation, diffusion, and CVD processes by Helmut-Seier in Germany in the 1960s. Vertical diffusion reactors were first developed in the early 1980s by Tempress in the U.S. However, at that time, the problem of horizontal furnaces was not serious, and it was not replaced by vertical furnaces. The need for vertical furnaces increased as the process entered into the submicron region and the wafer diameter shifted from 150 mm to 200 mm. Hitachi and KOKUSAI ELECTRIC jointly developed a vertical furnace in the mid-1980s. The VERTEX series of vertical furnaces for oxidation, diffusion and CVD was commercialized by KOKUSAI ELECTRIC in 1986. Koyo Lindberg (after Koyo Thermo Systems), TEL Thermco (after Tokyo Electron) and ASMI also started selling vertical furnaces.

Not only the reduction of fine particles, but also the uniformity of the process in the wafer was greatly improved in the vertical furnace by introducing the rotation mechanism of the wafers. Furthermore, compared with horizontal furnaces, automatic transfer of wafers became easier, and productivity was drastically improved by reducing the installation area of the equipment and reducing the frequency of quartz parts replacement.