

## Late 1960s

### Formation of oxide films by normal-pressure CVD

#### ~ Process Technology ~

In the early semiconductor (especially silicon) manufacturing, thermal oxide films formed by thermally oxidizing silicon were used for the insulating films. However, thermal oxide films have restrictions such as (1) they can be formed only on the exposed silicon substrate, (2) thermal oxidation is necessary at high temperature for a long time, and (3) it cannot be done after the Al interconnect formation, and so on. However, with the advent of atmospheric pressure CVD in the 1960s, not only these drawbacks were solved, but also it became possible to form oxide films doped with impurities such as phosphorus and boron.

By being able to form oxide films doped with phosphorus after the interconnect process, the reliability of the device was dramatically improved and plastic mold packaging such as epoxy and the like became possible. In addition, smoothening of the steps of the underlying structure by reflow of phosphorous doped oxide films was realized, and it became possible to make multilayered structure of poly-silicon gates and metal interconnects.

Normal pressure CVD is a process of forming silicon oxide films on the wafers by flowing reactant gases such as silane and oxygen on the wafers on the heated plates. In this method, the underlying layer does not need to be silicon, and a relatively thick film (1 micron or more) can also be formed at a relatively low temperature of about 500°C or so.

In terms of the equipment structure, it is common to place multiple wafers on a circular or rectangular high temperature plate, which is rotated while processing in some cases. Initially, they were in-house made by device makers, but since 1970 they became commercially available from Amaya Seisakusho, AMAT, Watkins-Johnson and others.



In-house made atmospheric pressure CVD equipment (Toshiba)