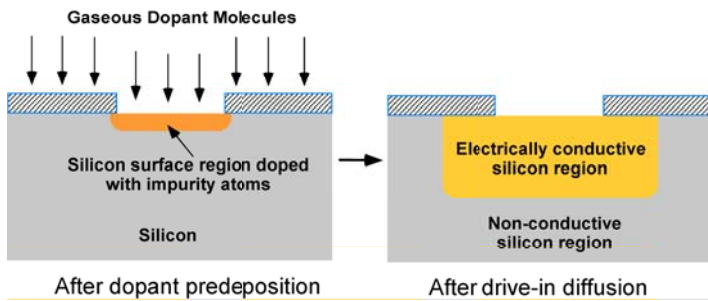


(2) Doping, Diffusion, and Annealing



Drawing of wafer surface showing doping and diffusion process to form a region of high electrical conductivity

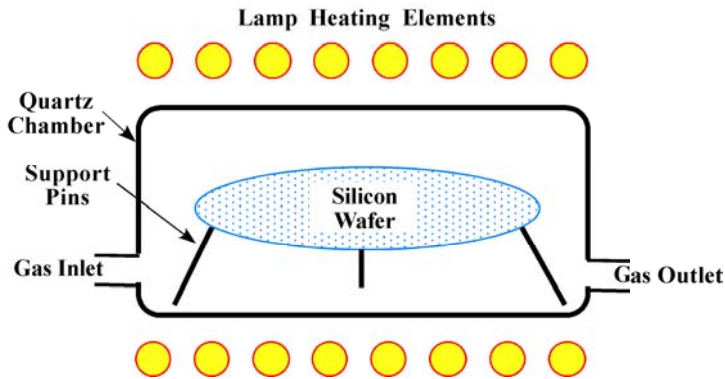


Diagram of rapid thermal annealing tool



A rapid thermal annealing tool in SNF

Properties of materials used in nanostructures can be modified by intentionally “doping” them with impurity atoms. For example, adding arsenic atoms to silicon makes the silicon more electrically conductive by producing free electrons, while adding boron makes silicon more conductive by producing “holes” (the absence of electrons in chemical bonds). Regions of different doping types are used to produce transistors and other devices.

One method for doping is to heat the wafers in the presence of dopant species gas sources. Tube furnaces just like those used for CVD deposition can be used (see next poster). Masks of deposited and patterned films may be used to limit doping to localized areas. **Another technique is ion implantation.** Here ionized dopant atoms are accelerated to the wafer surface by electric fields. This delivers a precise amount of dopant, but damage to the wafer surface is created which must be repaired.

Annealing is done to further improve the properties of the structure, including repairing any damage. Movement, or “diffusion,” of the dopant may also occur – sometimes intentionally to drive-in the dopant deeper in the structure. Tube furnaces can be used for these processes. However, sometimes minimal diffusion is desired during annealing. To minimize diffusion, rapid thermal annealing (RTA) can be used, in which a high temperature anneal is done for a very short time.

SNF has numerous doping, diffusion, and annealing tools, including furnaces, RTP’s and an ion implanter.