Late 1980s
Single wafer cluster tools
~ Discrete Semiconductor/Others ~

In front-end of semiconductor manufacturing process, cleaning, diffusion, deposition, and etching except for mask patter exposure on wafer were mainly performed by batch processing equipment that processed multiple wafers. In the etching process, NIPPON ELECTRIC VARIAN (after CANON ANELVA) developed a multi-chamber single-wafer RIE (Reactive Ion Etching) system in 1978 to increase processing capacity. In the late 1980s, the development of the RIE method, which used a high-density plasma ion source to increase etching speed, led shift of the batch system to single-wafer system. Some deposition processes were also shifted to single-wafer systems.

As the development of single-wafer etching and deposition processes, multi-chamber systems with multiple process chambers were widely used. Drytek (a division of General Signals, later a division of Lam Research) developed a four-chamber single-wafer dry-etching system (Quad) in 1984, which was improved to a cluster tool for continuous processing of multiple fabrication processes in 1987. In the same year, AMAT adopted a single-wafer multi-chamber platform (Precision 5000), which enabled to accommodate single-wafer process chambers for CVD and dry etching. For example, as shown in Figure 1, after forming the gate electrode of a MOSFET, a low-concentration drain layer was performed by ion implantation, sidewall spacers were formed by successive deposition of insulating film by CVD and anisotropic dry etching in a cluster tool. (Afterward this, a high concentration drain layer is formed by ion implantation using the spacer as a mask to form a Lightly Doped Drain (LDD) structure.) Since the throughput of single-wafer processes was improved by using multi-chambers, cluster tooling, which enabled continuous processing of multiple processes, had led productivity improvement with contamination-free process quality and low waiting time between processes.

Figure 2 shows a typical cluster tool structure. A robot in a transfer chamber carried a wafer from the load lock room to the single-wafer process chamber and processed the wafer. Continuous processing could be possible by setting up different process chambers and wafers transferred between chambers. Cluster tools continued to evolve over the years. AMAT introduced a cluster tool (Endura 5500) that coupled two transfer chambers to enable continuous processing of high vacuum sputtering and low pressure processes such as CVD, dry etching as well as Rapid Thermal Processing (RTP) in 1990. In particular, as VLSI miniaturization progressed, contact resistance between metal layers due to metal surface contamination became a problem in multilayer interconnections. The cluster tool that performed surface cleaning and metal film deposition in a continuous process became more effective to avoid such contact resistance issue.

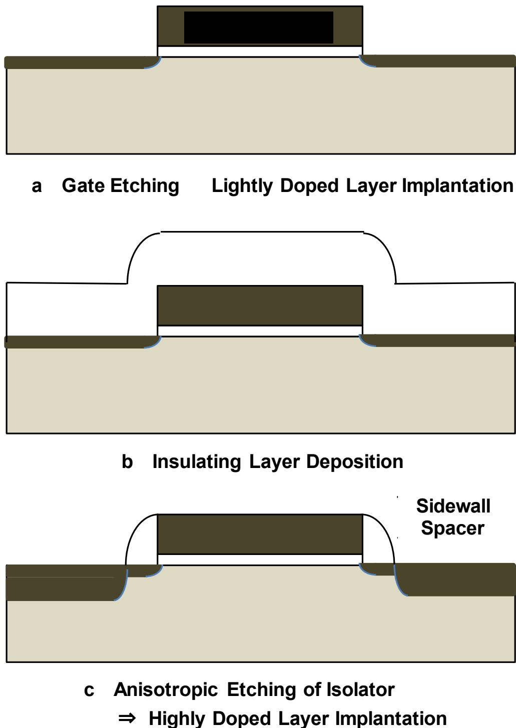

Figure 1 Fabrication process of LDD structure

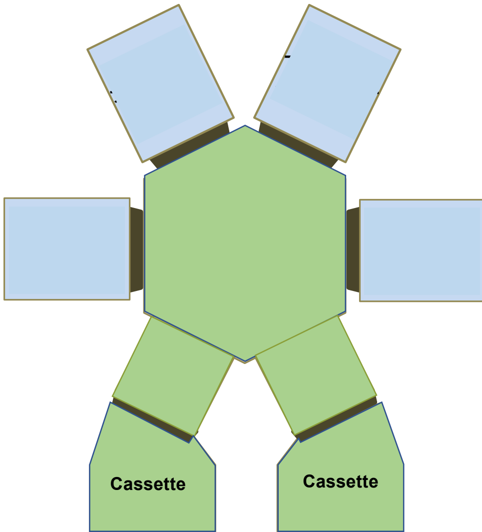

Figure 2 Structure of cluster tool