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Late 1970s

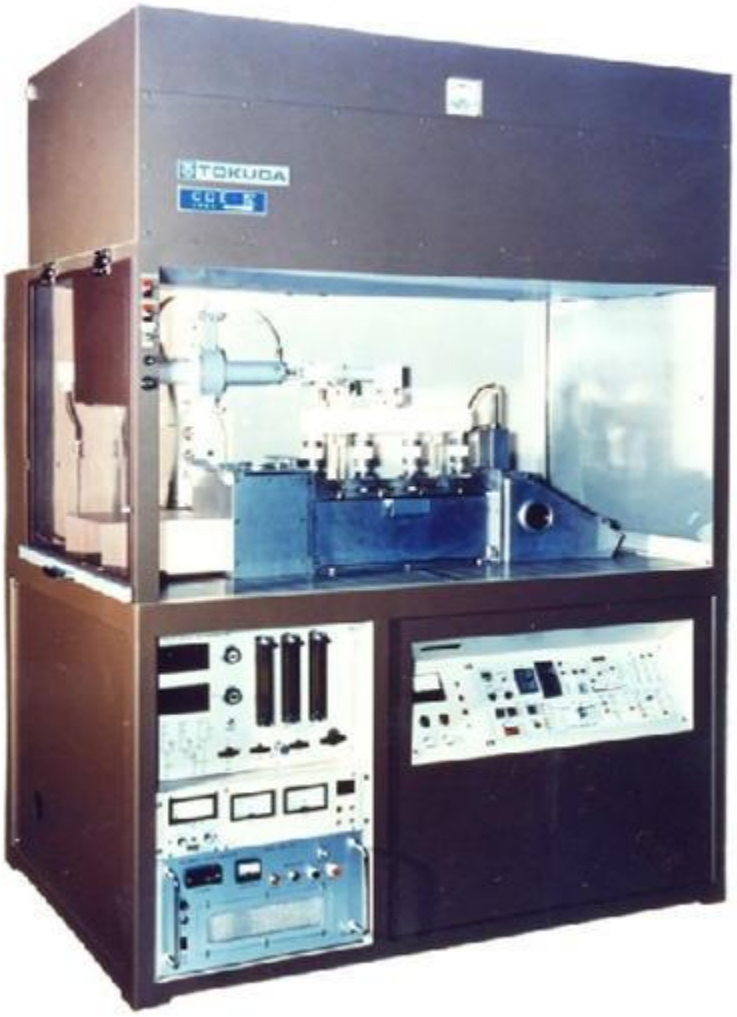
Usage of isotropic plasma etching

~ Process Technology ~

Dry etching appeared for the first time as isotropic plasma etching. Until that time, etching of Si based materials such as Si or SiN was performed by wet etching with fluoric-nitric acid or phosphoric acid solutions. However, there were problems with wet etching such as; (1) the problem of insufficient uniformity, (2) insufficient resistance of resist against the etching at elevated temperatures, and (3) difficulty of etching end point detection. Also, there were other problems in resist removal such as; (1) the use of a highly toxic organic solutions in resist removal after Al interconnect patterning, and (2) new processes in which resists could not be removed due to introduction of ion implantation, and so on. Most of these problems were solved by plasma etching that appeared in the 1970s.

Precise etching of polysilicon and SiN by plasma etching became a promising factor for mass production of process modules such as silicon gate and LOCOS. In particular, the precise etching directly connected to the definition of W and L dimensions of transistors owed much to the technology of end point detection which was developed in conjunction with dry etching.
Isotropic plasma etching methods are roughly divided into two: (1) a method of generating plasma directly in a wafer chamber, and (2) a method of plasma generation at a different chamber and transporting the generated radicals to a wafer chamber (chemical dry etching). In principle, etching is performed by chemical reaction by exposing the wafer surface to the etching gas molecules (atoms) activated by plasma. Etching gas is introduced into an evacuated chamber, and plasma is generated by microwave. Fluorine-based gases were widely used as etching gases, and oxygen was widely used for ashing. In addition, automatic detection of the end point was made possible by monitoring the plasma itself or the light emission by the reacted products, and the process automation advanced.

One of the features of chemical dry etching is its high selectivity of etching by materials, and it has been applied to selective etching of Si with respect to SiO_2, selective removal of an organic material from an inorganic material, and so on. Attempts to use plasma in semiconductor processes was taking place since the 1960s, but it was in the 1970s when they began to be put into practical use, and barrel type plasma etching apparatuses were released from several companies. The application was primarily photoresist stripping, and in Japan, Tokyo Ohka announced a resist stripping apparatus using plasma in 1971. Also, a chemical dry etching apparatus in which wafers were separated from plasma generation was released by Tokuda Seisakusho (present; Shibaura Mechatronics Co., Ltd.) in 1978.



Chemical dry etching equipment by Tokuda-Seisakusho CDE-4
(By courtesy of Shibaura Mechatronics)

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