

## Early 1990s

### High-density plasma (ECR: electron-cyclotron resonance and ICP: inductively coupled plasmas) etching and CVD

#### Process Technology ~

HDP (High Density Plasma) technology emerged in the early 1990s. In the 0.35 $\mu$ m generation and beyond, microfabrication of deep trenches (deep trench capacitors and shallow trench isolation) required a higher density plasma etcher. The equipment were released one after another such as an ECR etcher from ANELVA in 1989, a microwave plasma etcher from Hitachi in 1990, a TCP etcher from Lamb Research 1992, an ICP etcher from Applied Materials in 1993, and so on.

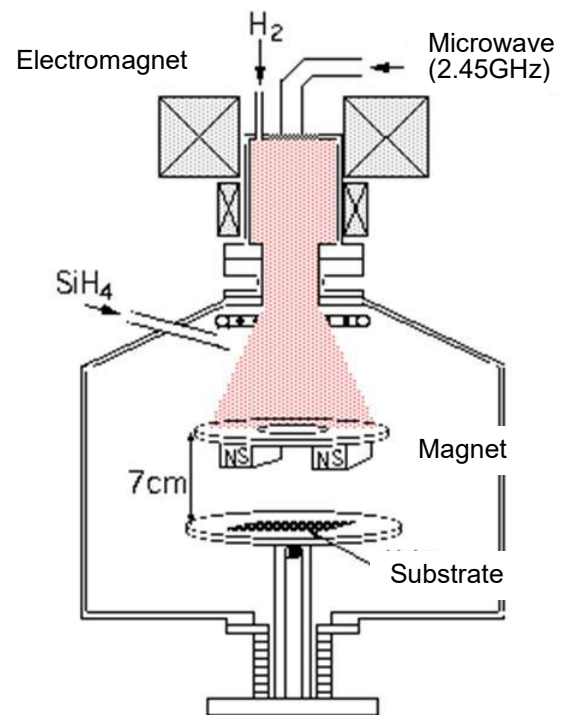
By increasing the plasma density, it became possible to etch faster, deeper, and more vertically, but control of plasma damage became an important issue.

In order to embed in microfabricated trenches, a CVD apparatus using the high-density plasma combined with bias voltage was also proposed. Many companies tried to apply it to CVD, and Lam

Research released an ECR type CVD equipment in 1995. Among them, the embedding CVD was widely used which utilized the sputter etching effect by the bias voltage during the high-density plasma CVD, surpassing the conventional reflow type CVD, owing to its embedding characteristics of the unique mountain type deposition shape.

High-density plasma CVD required high vacuum, and it was urged to develop and improve turbo pumps that were in large sizes and could withstand heavy load.

By the way, these technologies were rapidly adopted for etching and deposition of thick films in several hundred microns in the field of MEMS, which is less susceptible to plasma damage.



Schematic diagram of ECR (electron cyclotron resonance) CVD