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Late 1990s

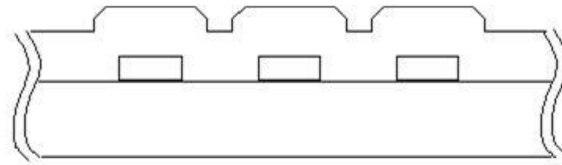
Usage of chemical–mechanical polishing

Process Technology ~

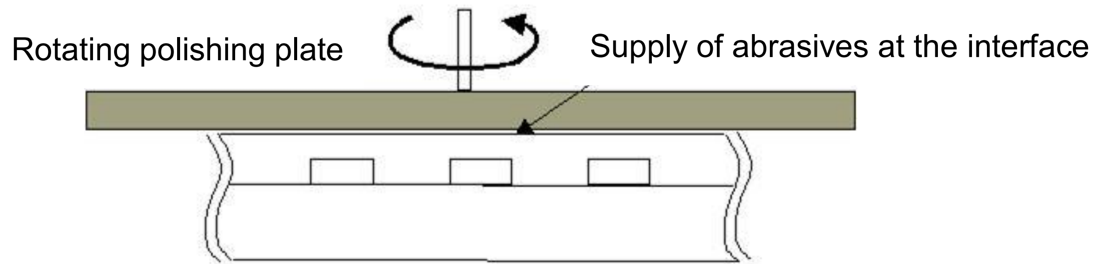
CMP (Chemical Mechanical Polishing) technology is one of the surface flattening techniques. Beginning in the latter half of the 1980s, practical application advanced mainly at IBM, and unlike flattening such as reflow and etch-back until then, it is characterized by mechanically polishing to obtain a nearly perfectly flat surface.
As a result, totally new process modules such as STI (shallow trench isolation) and damascene interconnect could be put into practical use. Particularly, practical application of copper, which is difficult to process by dry etching, was made possible largely due to adoption of damascene technology. In addition, planarization by CMP became a savior for the focus depth tolerance of lithography, which greatly contributed to acceleration of miniaturization.
Flattening by CMP is performed by pushing a wafer downward on a large table on which a polishing pad is laid, and by rotation and revolution while supplying abrasive. At this time, a larger pressure is applied to the protrusion than the concave portion, and the pressure dependence of the polishing rate produces selectivity of the polishing rate of the convex and the concave portions, thus realizing flattening.

Initially, American equipment such as the one from Westech were mainstream, and because of the problems such as dust generation from abrasives, they were generally installed in the CMP dedicated rooms. In the first half of the 1990s, Ebara Corporation developed a unit that integrated post-cleaning and it could be installed in a clean room, making it easy to introduce it into semiconductor processes.
In CMP, expendable items such as abrasives and polishing cloths, which greatly influence process performance, are very important besides the equipment itself. Most of the abrasives are those in which fine particles of silica are dispersed in water and chemicals for promoting and controlling polishing are added. Also, as the polishing cloth, foamed polyurethane is often used. Initially, the materials from Cabot (abrasive) or Rodel (abrasive cloth) were mainstream, but recently JSR (abrasive and polishing cloth), Hitachi Chemical (abrasive), Fujimi (abrasive) supply high quality materials, showing the presence of Japanese manufacturers.

From the early stage of development, particle residues and scratches (polishing scratches) were the problems, but they have been overcome by the improvement of post-cleaning and abrasive techniques. In post-cleaning, scrub cleaning with PVA (polyvinyl alcohol) sponge is widely used, and if necessary, a cleaning chemical is used in combination. Due to the advancement of miniaturization, these are still important technologies and development efforts are still being made



(1) CVD deposition of insulating film



(2) Flattening by CMP polish

Fig.1: Flattening process by CMP

Fig.2: Early dry-in/dry-out CMP equipment EPO-1141
(By courtesy of Ebara Seisakusho)