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1970's
Proximity Aligner and Projection Aligner

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In the contact exposure method, the photomasks were brought into close contact with the silicon wafers coated with the photoresist, so that the photomasks were easily damaged due to scratches on the photomasks and adhesion of foreign matters. In addition, although resolution improvement was required when the fine processing level advanced from 5 μm to 3 μm, positive resist with excellent resolution characteristics which were used for chromium mask fabrication could not be used, because it was highly brittle novolac resin material and easily damaged in contact exposure.

In order to solve these two main drawbacks, a proximity aligner and a projection aligner were developed to expose with the photomask being kept away from the wafer. The first machine of this method was PPC-1 developed by Canon in 1970 for the 1x magnification exposure (Fig. 1). This method was developed as proximity exposure apparatus with the proximity distance of 10 to 20 μm, and it was released from Kasper and Canon (PLA - 300 F) in 1974. Although the resolution of the proximity exposure method was about 4 μm, which was inferior to 0.5 μm of the contact exposure, the manufacturing yield was greatly improved up to the vicinity of the 5 μm process. In 1977 Canon further launched the world's first machine (PLA-501FA) equipped with a laser scanner auto-alignment mechanism (Fig. 2). After that, the aligner became an automated system. Yield and productivity were greatly improved, without depending on the skill of the workers.

As a method of compensating for the drawback of lower resolution when separating the photomask from the wafer, an optical system of 1x projection exposure, having a field of view on a circular arc by combining a convex mirror and a concave mirror was developed, and the photomask and the wafer were simultaneously scanned to expose the front face of the wafer. This exposure apparatus was released by Perkin Elmer in 1973. The initial resolution was 2.5 μm.

Thus, in the 3 μm to 2 μm processes in the latter half of the 1970s, proximity and projection exposure methods with the positive resist became mainstream.

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Figure 1 The first Proximity Aligner (PPC-1)
(provided by Cannon Inc.)

Figure 2 Proximity Automatic-Aligner (PLA-501FA)
(provided by Cannon Inc.)

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