1970s
Electron Beam Lithography System

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Since the electron beam (EB) lithography can directly draw a finer pattern than a light method without using a mask, development was progressed from the 1960's in the United States, Europe and Japan. In Japan, in the large scale project of "Research on Super High Speed Computers" by National Institute of Advanced Industrial Science and Technology, the development of electron beam lithography for the development of high speed semiconductor devices started in 1966 at Electronic Technology Research Institute, and this was completed by JEOL in 1967(JEB-2B).

In the 1970's, the electron beam (EB) lithography was regarded as a promising candidate which would replace optical lithography, and practical development activities were carried out simultaneously at Bell Laboratories, IBM, NTT, Toshiba, Hitachi, Fujitsu and others. The first practical method was the combination of EB lithography system and a positive EB resist of PBS (poly-butyl- sulfone) based polymer, and it could be applied to photomask fabrication and to wafer exposure. This drawing machine was released from ETEC in 1977.

In Japan, the VLSI Technology Research Association was established in 1976, and joint development of EB lithography was carried out by Toshiba, Hitachi, and Fujitsu. In 1978 – 79, a raster scan type EB lithography (VL-R1 / 2), variable shaped beam type EB lithography (VL - S1 / 2), and field emission electron gun type EB lithography (VL - F 1) were developed and put to practical use. PBS type electron beam resist developed by Bell Laboratories was used, and Chisso Corporation commercialized it in Japan. At the VLSI Technology Research Association, electron beam resists were developed in parallel with the machine development, and in 1980 a positive type electron beam resist (EBR) with improved resolution was developed by Toray Industries, Inc., which was based on tetra-propyl-α-chloro-acrylate polymer, and it became the standard type EB resist in the 1990s.

Compared with the light exposure method, the electron beam lithography has advantages of (1) high speed pattern generation, (2) high resolution, and (3) mask-less exposure, and it was used for LSI development trial manufacturing, small quantity/multi product LSI manufacturing, and high frequency transistor production. However, since graphic patterns are rendered one by one, the throughput is remarkably low as compared with the light exposure method, and it is unsuitable for mass production of general-purpose LSI production

On the other hand, the number of patterns in the photomask for light exposure increased exponentially as the LSI integration level advanced, and it took more than 100 hours to manufacture a mask by a pattern generator, which was reaching the practical limit. In this situation, the feature of high-speed pattern generation of EB lithography became effective and it became indispensable for photomask fabrication and reticle production for reduced projection stepper that appeared later. Thereafter, the electron beam lithography system has been used for reticle manufacture until today for the fine pattern

fabrication of nm scales.

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