High Resolution Patterning Technology: a View of the Future

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During the last half century scientists and engineers have devised methods and materials that enable manufacturing of the incredibly small and ever shrinking structures that are the basis of the microelectronics industry. The ability to manufacture such structures and the devices derived from them is a tribute to the ingenuity of man and it is an accomplishment that has changed society in remarkable ways. Classical photolithography, the process that has enabled this process has now reached physical limits. Efforts to push that technology to provide still higher resolution by the historical paths of wave length reduction, increase in numerical aperture and reduction in the Raleigh constant have been abandoned. Is this the end? Can scaling continue?? Of course it can! It is not over yet!

Various incredibly clever tricks have been devised to extend photolithography, some of which are already in use in full scale manufacturing. Unfortunately, these tricks add complexity to the patterning process and carry an associated increase in cost. The high cost of these clever, but complex processes and the even higher cost of the alternatives that are being pursued threaten to change the economics of the semiconductor manufacturing industry. We will review some of these resolution extension tricks including advances in materials for directed self-assembly of block co-polymers and a new pitch doubling technique that requires no extra processing steps. Finally, Step and Flash Imprint lithography, a potentially disruptive, much lower cost, high resolution patterning technology has emerged as a potential adjunct to photolithography. We will briefly examine the state of this interesting alternative path to continued scaling.