Source-mask optimization: pushing ArF further

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Abstract | Tachyon SMO offers source-mask optimization. It can expand your process window for next-generation technology nodes by 40-70% compared to previous tools, helping push ArF immersion lithography further than it has ever been. And drawing on our extensive expertise in illumination sources, OPC / RET and computational lithography, it ensures the output source shape and design are fully manufacturable.

Feature shrink is a constant drive in the semiconductor industry. So while 45-nm production is ramping up, development work is already underway for the next technology nodes. Designers are creating novel designs to exploit smaller features. But the question is: Can you print them?

The 3x memory and 2x logic nodes will be manufactured using immersion ArF lithography. However, the extremely low k₁ values this entails mean process windows could be very small. To help expand process windows and push ArF lithography even further, ASML Brion has launched Tachyon SMO: a source-mask optimization (SMO) tool for lithography development at next-generation technology nodes. (See Fig.1)

The first step on the ‘holistic’ path
For years, lithographers have successfully printed smaller and smaller features by optimizing each individual process step. But at the ultra-low k₁ values of 3x and 2x nodes, this step-by-step approach no longer works. We need to start looking at the IC manufacturing process as a whole.

Tachyon SMO is the first step on this ‘holistic’ path. It simultaneously co-optimizes...
Take optimization to the next level

Tachyon SMO starts with an unconstrained co-optimization of the mask design and scanner source. It then uses the tightly integrated ASML scanner parameters and Brion’s computational lithography solutions to ensure all relevant information (such as modeled illumination profiles and mask constraints) is applied to the optimization process. (See Fig.2)

The end result is a manufacturable mask design and freeform diffractive optical element (DOE) that together enable 40% or larger process windows gains over iterative SMO tools. What’s more, Tachyon SMO lets you apply your own constraint levels to the optimization, for example, to check if a pattern can be printed using existing DOEs.

Used in the lithography exploration phase, Tachyon SMO reveals what’s possible with immersion ArF. It lets you validate your next-generation design rules, and ensure an optimal process window from R&D through to production. You can even explore which layers need double patterning and which can be realized with single-exposure techniques, thereby minimizing your total cost per layer.

Significantly larger process windows than iterative SMO tools