EUV free-electron laser requirements for semiconductor manufacturing

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Abstract:

Laser-produced plasma extreme-ultraviolet (EUV) sources currently power EUV lithography tools, supporting advanced semiconductor manufacturing research and development. However, a source with sufficient power to support high-volume manufacturing has yet to be realized, but the sheer number of installed tools indicates the transition to EUV lithography is no longer a question of 'if' but 'when'. After the initial insertion of EUV lithography into manufacturing, the prerequisite dose scaling with technology node will be steep and therefore drive the EUV cost-per layer. Free-electron lasers (FEL) may offer a low-cost, high-power alternative and facilitate further expansion of lithographic capabilities, including the development of high-NA and high-throughput NA 0.33 scanners. Adaptation and development of existing scientific light source knowledge, components and infrastructure for the implementation of a viable industrial light source requires collaboration between academic and manufacturing communities. Considerations for an integrated FEL lithography light source are discussed, focusing on the specific needs of the semiconductor industry. Emitted power, reliability and stability requirements are outlined with the intent of supporting a manufacturing fab's entire EUV lithography module. Potential high-NA EUV cluster requirements and the further lithography wavelength reduction to 6.x nm are also explored as potentially benefiting from FEL source development.