

# Free-electron lasers for advanced semiconductor manufacturing needs

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There is intense current interest in applying short-wavelength FELs to semiconductor manufacturing. Next-generation FEL techniques are being developed to address two advanced chip fabrication challenges: high-average-power lithography sources; and few-nm-resolution metrology. Aspects of the significant new activity in EUV lithography FELs, likely to impact the industry in the coming years, are reviewed. Beyond lithography, new, non-destructive 3D methods are critical to future US semiconductor manufacturing. Storage ring-based studies of chip imaging with coherent hard X-rays using ptychographic tomography and laminography techniques have achieved 4-nm voxel resolution. The methods are rapidly maturing, but the coherent X-ray source characteristics must be improved. An ultra-compact X-ray FEL is an attractive, compact and cost-effective option for chip fabrication plants. Contours of a design, based on ultra-high electron beam brightness, high-gradient acceleration, and cutting-edge regenerative amplifiers, that can deliver the needed coherent flux are examined. A development path, from concept to rapid realization of a transformative XFEL-based application is discussed.

## Footnotes

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