

Autocorrelation functions of periodic patterns in soft X-ray metrology of semiconductor devices

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In ASML's soft X-ray (SXR) metrology concept, a pattern on a semiconductor wafer is illuminated by broadband SXR radiation (wavelength 10 nm to 20 nm); the diffraction pattern is captured on an image sensor.

These patterns are typically periodic test patterns (also called "targets") that are added by the manufacturer of semiconductor devices, for quality control purposes. Many state-of-the-art devices start with a fin pattern with a pitch of < 50 nm, followed by various process steps that result in patterns with a larger period (a multiple of the fin pitch). In between the production steps, various parameters need to be monitored, such as overlay (in-plane offset between patterned layers), in-plane feature sizes, and etch depths.

It is possible [1] to transform a diffraction pattern into a 3-dimensional autocorrelation function of the target pattern, with very limited prior knowledge of the exact layout of this target pattern. This autocorrelation function reveals information on the layer structure and overlay. The method will be explained and illustrated with data.

[1] H.K. Nienhuys et al., US Patent application 20230040124 A1.