Active control of thermal aberrations in projection optics for EUV Lithography

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Abstract

In EUV Lithography optical systems it is unavoidable to make use of reflective optics (i.e. mirrors). There is no material transparent enough to use lenses (refractive optics) and all materials will absorb EUV light. When exposing wafers light is absorbed as it travels through the projection optics of the scanner. This causes the mirrors in the projection optics to heat up and deform. This deformation will give thermal aberrations affecting key performance indicators such as image quality, focus and overlay.

In order to minimize the deformations the mirrors may be made from a material with ultra-low thermal expansion. For a specific temperature this material has zero thermal expansion. Since these mirrors may be subjected to different thermal loads (e.g. illumination settings, thermal crosstalk between mirrors) a feedback controller is investigated to maintain the temperature of the mirrors at this specific temperature. Heat load variations are compensated by the output of a heating element distributed to the mirror optical surface. Simulations and experiments, on a dedicated test set-up, have shown that by applying this control loop it is possible to compensate these thermal aberrations.