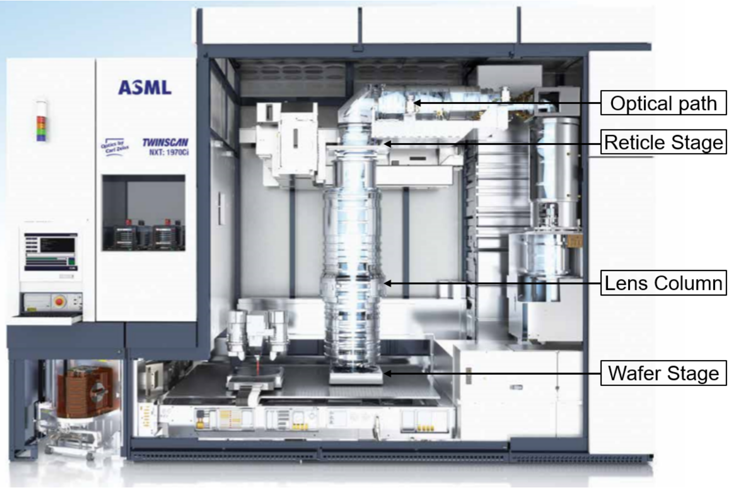
Master Project
Reticle heating induced image distortion control

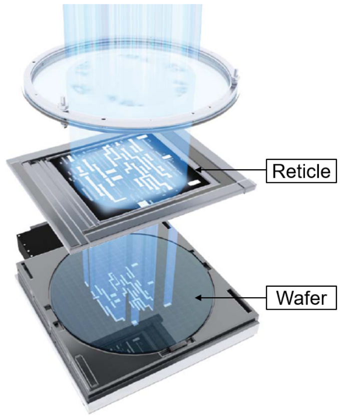
Peyman Mohajerin Esfahani, Delft Center for Systems and Control, TU Delft
P.MohajerinEsfahani@tudelft.nl
Nathan van de Wouw, Dynamics and Control Group, TU Eindhoven
N.v.d.Wouw@tue.nl

Context

At ASML, requirements constantly evolve to improve the performance of their lithography tools with respect to accuracy (overlay). As a result, controlling temperature fluctuations and deformations of modules, caused by thermal disturbances, becomes more and more important. Typical conditioning solutions include passive conditioning (open loop control), active conditioning (closed loop control) and error correction (adjusting setpoints based on known or estimated errors).

This project focuses on the problem of reticle heating. A part of ASML's lithographic systems uses deep ultra-violet (DUV) light to print patterns (images) on a wafer. During this printing process, the DUV light-beam first passes through the reticle, a quartz structure containing the image to be projected on the wafer. Thereafter, the light beam passes through the optical column, consisting of multiple actively controlled lens elements to compensate for a sub-part of these image distortions (error correction). However, during this process the reticle heats up, leading to two image distortion effects due to: 1) thermal deformations of the reticle and 2) temperature variations of the air underneath the reticle. Currently, to prevent these image distortions, setpoints of the actuator elements are adjusted (error correction). In addition, temperature controlled air is blown over the top-surface of the reticle (passive conditioning).





Project tasks

This assignment focuses on optimal integration of active conditioning (closed loop control) and adapting setpoints based on known or estimated errors (error correction) for the reticle heating problem, taking both image distortion effects into account. A model describing the thermo-mechanical reticle dynamics is available. The project involves the following tasks:

1. Investigate the current control design, including an analysis of the system dynamics and response to the disturbances, and its limitations.
2. Evaluation of the performance, in terms of the two image distortion effects, that is achieved with the current approach (baseline).
3. The formulation of the control goal of the controller, integrating active conditioning and error correction.
4. The design of a controller to minimize image distortions, including an analysis on the impact of different disturbances and uncertainties on the performance.

The project will be conducted at ASML, the largest supplier in the world of lithography systems for the semiconductor industry, in collaboration with the Dynamics and Control group at TU Eindhoven and Delft Center for Systems and Control at TU Delft.