Master Project

Point-of-Interest Control in Reticle Cooling

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

In view of the increasing demands on scanning resolution and wafer throughput, lithographic systems like wafer scanners heavily depend on the control systems being used. To meet the ever tighter performance specifications, advances in systems and control theory often translate to means of meeting such specifications. An interesting and powerful approach is optimization-based approaches that explicitly take into account the propagation of uncertainty as well as the dynamics and control constraints. The focus of this project is to utilize the recent developments in this area and deploy them to the application of reticle stage synchronization.

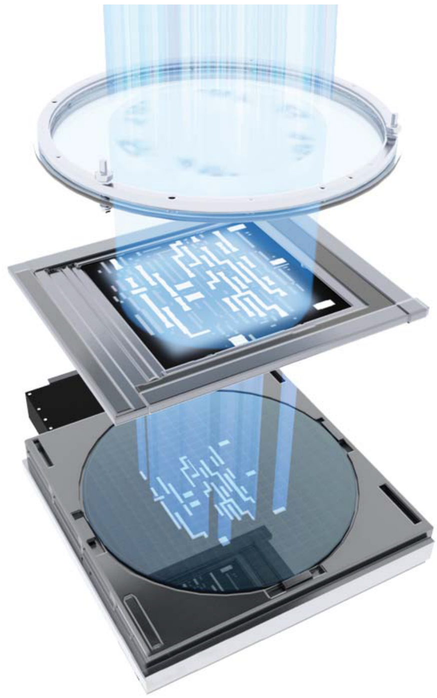

Figure 1: Wafer/Reticle Stage Synchronization

In this regard, the problem of reticle cooling is considered. In the lithographic process, deep ultra violet (DUV) light is used to print patterns from a mask (or so-called reticle) onto the light-sensitive layers of a wafer. As light is being blocked by the reticle, it typically heats up, leading to reticle deformations. To prevent these deformations, temperature controlled cooling air is blown over the top surface of the reticle. In controlling the cooling air, however, it is not possible to measure the deformations (nor temperatures) within the reticle. This poses a problem, since the reticle deformations should be kept small in order to keep the projected image as undistorted as possible.

Project tasks

This project aims at minimizing reticle deformations, i.e., reducing temperature gradients in the reticle, by actively controlling the cooling air temperature. To this end, a thermal FEM model of the reticle may be used to study (and possibly control) the temperature at the central lower surface of the reticle, which is often also referred to the point of interest. The project involves the following parts:

1. Investigate the state-of-practice in reticle cooling control; this part typically involves a description of the current control design, the main disturbances acting on the system, analysis of the obtained performance with this design, and its limitations.
2. Point-of-interest modeling; this part involves FEM modeling toward the point-of-interest.
3. Model-based controller design; this part involves observer design, i.e., using the temperature measurement at the point-of-control together with the FEM model to provide a fair estimate of the temperature at the point-of-interest along with an active control strategy for controlling said point.
4. Develop an appropriate optimization-based control; this part mainly involves the adaptation of the controller using recent advances in data-driven optimization literature in order to deal with uncertainty and disturbance modeling.

⇒ The project will be conducted at ASML, the largest supplier in the world of photolithography systems for the semiconductor industry.