Modeling of defect transport in EUVL plasma chambers

Alex Likhanskii, Chuandong Zhou, Peter Stoltz
Tech-X Corporation, 5621 Arapahoe Ave, Boudler CO 80303
likhansk@txcorp.com

Vibhu Jindal, Patrick Kearney, Arun John
SEMATECH, 257 Fuller Road, Albany, NY 12203

Extreme ultraviolet lithography (EUVL) is the leading next generation lithography technology to succeed optical lithography beyond the 22 nm technology node. Reducing defects on extreme ultraviolet (EUV) masks is one of the most critical issues to be addressed for commercialization of EUV lithography. The EUV mask blanks are deposited by ion beam deposition system where particle are generated during the deposition process and within system providing major sources of mask blank defects. Transport of particles in an ion-beam sputtering deposition system is a very complex electrostatic problem in order to devise mitigating solutions. The transport study of particles in similar plasma systems is highly important and beneficial but not limited to development of EUV mask blanks. The trajectory of these charged particles or atoms is affected by the ambient plasma density and temperature, the time dependent charge on the particles or atoms, gravitational effects and the potential drop between target and substrate, among other effects. In order to better understand contamination of surrounding components and ways to control the transport of material/particles, we employ numerical simulation of a typical ion-beam sputtering system including transport of particles and sputtered material. We use the plasma simulation framework VORPAL, developed by Tech-X Corporation and CU Boulder, for studying these effects. In this work, we will present simulation results of the transport of sputtered material and particles in a parallel plate geometry for particle size on the order of 10-100 nm, plasma density of 10^{12} cm^{-3} and applied voltage on the order of 100V representing the ion beam deposition system. In particular, we address the effects of the plasma sheath at the target and substrate. The effect of charging on target on particle transport is discussed in detail. Further mitigation solutions such as charging of shield surfaces to deter the particle transport towards active area are outlined.