The Bottom-Up Method: Measuring and controlling energy of tin ions emanating from laser produced plasmas

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Extreme ultraviolet lithography (EUVL) is essential for the mass production of the most advanced integrated circuits [1]. Laser produced plasmas (LPPs) are used for nanolithography because they are efficient sources of EUV light. The material of choice for EUVL is tin (Sn), because tin plasmas radiate in a tight band around 13.5 nm [2, 3]. This wavelength is important because there are no suitable lenses, which conventionally are used for lithography, for EUV light. To be able to image the nanolithography mask, multi-layer mirrors (MLMs) are used, Molybdenum-Silicon MLMs reflect 70% of light at 13.5±0.135 nm (so called 'in-band' light) [4]. However, not all of the energy of the input laser is converted to EUV radiation, debris are also created, to name a few: so called 'out of band' light, clusters of neutral atoms and tin ions are also created. The goal is to obtain a conversion efficiency (CE) that is as high as possible. Thus we would like to minimize the energy that goes into debris and maximize the energy that is converted to in-band light. Tin ions can be harmful debris, because they are able to damage the MLMs, deteriorating their reflection and reducing lifetime [3, 5]. Thus it is useful to obtain information about the kinetic energy that these ions have and to know under which angle they are ejected.

At the Advanced Research Center for Nanolithography (ARCNL) in Amsterdam, The Netherlands, fundamental research is done that is relevant for industrial nanolithography. My research is in the Extreme Ultraviolet (EUV) Plasma Processes group. My research focuses on tin ions emanating from laser produced plasmas in a setting comparable to industrial nanolithography. Using retarding field analysers (RFAs) and an analysis method developed at ARCNL, the Bottom-Up Method, we are able to get a charge resolved energy spectrum. Using 7 such RFAs allows us to also get an angularly resolved energy spectra, these show that emission is highly anisotropic. Currently my work is improving this method, identifying systematic effects that have not been included yet. In addition to this the aim is to see if it is possible to control the fraction of input energy that in converted to ion kinetic energy, by laser temporal or spatial shape for instance. My poster presentation will be about these systematic effects, and if possible will also include some results from experiments.

References

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