Recent progress in source development in the extreme ultraviolet for lithography and water window imaging

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Laser produced plasmas of Sn are now being developed and deployed for extreme ultraviolet (EUV) lithography at 13.5 nm for use with manufacturing tools containing Mo/Si multilayer mirrors with reflectivities close to 70% within a 2% bandwidth at this wavelength [1]. The emission is due to *4d-4f* and *4p-4d* transitions which overlap in a number of adjacent ion stages to produce an intense unresiolved transition array (UTA) [2]. In Gd the same UTA lies close to 6.7 nm where LaN/B multilayers have a theoretical reflectivity close to 80% though within a 0.6% bandwidth. We report recent progress and show that while Gd plasmas have a similar overall conversion efficiency (CE) to Sn at 13.5 nm, the higher plasma temperature required as well as the reduced bandwidth gives a lower actual CE [3,4]. Because the UTA imoves to shorter wavelength with increasing atomic number, it can be used for other applications, such as transmission x-ray microscopy for biological imaging in the water window. An alternative source in this wavelength region is provided by the *3d-4p* and *3d-4f* emission from third row elements, for example zirconium, as well as more conventional line sources such as hydrogen like C and N emission, now used with zone plate transmission optics [5]. We discuss the effects of mirror bandwidth on the development of a table-top water window sources based on laser-produced plasma emission combined with reflectance optics and how it can ultimately determine the choice of optimum source material [6].

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