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EUV Photoabsorption Spectroscopy of Hf Laser Produced Plasmas

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Very little atomic structure information is documented for the lower ionisation stages of 6th row elements above 30 eV [1]. Spectroscopic studies of hafnium (Hf) emission have been carried out in previous focused campaigns [2, 3] as well as studies of the isoelectronic series of ion transitions across hafnium, tantalum, rhenium & tungsten [4, 5].

Lowly ionised hafnium photoabsorption spectra in the 47-160 eV region were recorded using the dual-laser plasma technique [6], utilising tungsten as a back-light continuum source to probe a line plasma generated by focussing 1064 nm Nd:YAG radiation through a cylindrical lens onto a hafnium target. These spectra were recorded on a $\frac{1}{4}$ metre, flat field grazing incidence spectrometer, with a 1200 g/mm grating and a 2048 x 2048 pixel CCD camera, with inter-plasma time delays varied between 0-500 ns using a digital delay generator. A series of motors with micron accuracy were used to vary the x, y and z position of the targets and lenses, inside a vacuum chamber held at a pressure of $10^{-4} - 10^{-5}$ mbar.Varying the position of the absorber target with respect to the optical axis allowed different regions of the absorber plasma to be probed. Varying the position of the absorber lens with respect to the absorber target modified the focussing conditions of the absorber plasma. This allowed variation of the laser power density in order to optimise conditions for the distribution of particular ion stages within the absorber plasma. The absorbance, A, was determined using Eq. 1 [7]:

$$A = log_{10}\left(\frac{I_0}{I}\right) \tag{1}$$

Here I_0 refers to the continuum radiation captured from the tungsten back-light plasma, and I refers to that continuum captured after passing through an absorbing Hf plasma. Calculations are underway using the Cowan Suite of Atomic Codes [8] for Hf I-VI ions to begin the process of line identification in the photoabsorption spectra. FLYCHK [9] and a modified version of a simple, single temperature collisional radiative model [10] will be utilised in combination with line identification to estimate the electron temperature at different inter-plasma time delays for generation of synthetic spectra. Work completed to characterise these Hf plasmas in the extreme ultraviolet (EUV) will form the basis of future work in analysis of EUV absorption in plasmas for Hf other 6th row elements which will assist in ion identification for the characterisation & line identification of near infrared plasmas.

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