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Time resolved emission spectroscopy of the HIPIMS discharge

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Optical emission spectroscopy is valuable non invasive tool for determining the number density of emitting species in a plasma under some conditions and is in principle capable of very high time as well as spatial resolution. The aim of this work is to use emission spectroscopy to determine the effects of pulse shaping on the population of ionised species in the HIPIMS plasma. We also report on the application of a Fizeau interferometer for carrying out time resolved line shape studies that have sufficient resolution to determine the velocity distribution of the emitting species by means of analysis of the Doppler broadened profile.

HIPIMS is under active development as a deposition technique with potential to combine the advantages of the cathodic arcin providing deposition from ions with the advantages of sputtering in being macroparticle free. HIPIMS is however challenged by giving disappointingly low deposition rates. Pulse shaping has been proposed as a method for optimising the deposition rate in HIPIMS but detailed studies of the effect of pulse shaping on the degree of ionisation are not yet available. We report on the use of a fast high resolution spectrograph (Spectro Pro) to collectinformation on the ion population densities as a function of time during a HIPIMS discharge with various shaped voltage pulse profiles. We study the effect of gaps in the profile on the ion populations for titanium and copper discharges.

The demonstration of local thermodynamic equilibrium is problematic in high current glow discharge plasmas, especially when they are strongly time varying as in the HIPIMS plasma, some useful information on population ratios of emitting species can be obtained by actinometry using the intensities of both ion and emission lines. Some results will be presented on the HIPIMS plasma using a copper cathode.

The availability of fast intensified cameras offers an opportunity to use Fizeau interferometry to obtain simultaneously high wavelength resolution and high temporal resolution. Using copper as an example, we demonstrate how the Fizeau interferometer can give simultaneously high wavelength resolution sufficient to resolve the fine structure and Doppler broadening with sufficient temporal resolution to obtain this information at different times during a HIPIMS pulse.

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