Abstract:

A 2.2 meter grazing incidence VUV monochromator has been converted into a time-resolving spectrograph by the addition of a new detector system, based on a microchannel plate image intensifier linked to a 1024-element linear photodiode array. The system covers the wavelength range 15-1200 Å (typically 40 Å at a time) with resolution of up to .3 Å FWHM. Time resolution is selectable down to 0.5 msec. The system sensitivity was absolutely calibrated below 150 Å by a soft X-ray calibration facility. The spectrograph was installed on the Alcator C tokamak at MIT to monitor plasma impurity emission. There, cross-calibration with a calibrated EUV monochromator was performed above 400 Å. Calibration results, system performance characteristics, and data from Alcator C are presented.

Observations of impurity behavior are presented from a series of ICRF heating experiments (180 MHz, 50–400 kW) performed on the Alcator C tokamak, using graphite limiters and stainless steel antenna Faraday shields. Large increases in metal impurity levels were seen during the RF pulse, with iron increasing by a factor of 12 at the highest RF powers. Much smaller increases in carbon and oxygen were seen. Potential impurity sources and release mechanisms are discussed. Analysis of inferred iron source rates shows a linear dependence on RF power up to 400 kW, with no clear dependence on resonance conditions or bulk plasma parameters. However, a sharp increase in electron temperature, $T_e$, in the limiter shadow region, seen during the ICRF pulse, was well correlated with the iron influx rate. It is concluded from this and other evidence that enhanced sputtering of the Faraday shield due to an elevated sheath potential ($\phi_{sh} \sim 3T_e$) is the primary source of metal impurities during ICRF heating on Alcator C. This process, occurring at the limiter, is the dominant source of carbon and oxygen. These results are consistent with sputtering yields obtained from an edge erosion code, which utilized measured changes in edge $T_e$ profiles.