Motivation and purposes

High-Z elements like Tungsten and Molybdenum considered as a candidate for first wall material in ITER
  > Less sputtering yield and high melting point

Spectroscopic studies on impurities
  • To understand their production mechanism
  • To find out contribution in energy loss, etc.

Line analysis of EUV spectrum
  • Find out dominant charge states inside plasma
  • Identification of prominent line spectra of different charge states

Experimental Set-up

LHD (Large Helical Device) parameters during experiment;
  Magnetic field (B_T) – 2.64T
  Average major radius (R_m) – 3.75m
  Average minor radius (r) – 60cm
  Electron temperature (T_e) – 2.5keV
  Line-average electron density ~ 1.4x10^{13}cm^{-3}

Cylindrical Carbon coated wire of W and Mo injected
  Pellet size - 0.8mm in diameter and 0.8mm in length
  Wire size - 0.2mm in diameter and 0.5mm in length

EUV spectrum (30Å–500Å) monitored
  Using a flat-field EUV spectrometer
  Varied Line Space (VLS) laminar 1200g/mm holographic grating
  Spectral resolution - 0.16Å at 70Å
  CCD - 1024/255pixels, Pixel size - 26μm

Whole spectrum recorded from several discharges by moving CCD detector
  > Spectrometer acquire 160Å at a time

Accurate wavelength calibration done
  Line spectrum from carbon and other intrinsic impurities

Charge states of Mo and W ions determined
  Temporal evolution of intensity of line spectrum after pellet injection and temperature decay phase at the end of discharges

EUV spectrum and analysis

Tungsten Spectrum

1. Three well separated bands appeared
2. Peak of band around 30Å shifted from 34Å to 31Å when plasma temperature raised 0.75keV to 1.2keV after pellet injection
3. Many Isolated lines on top of pseudo-continuum

Molybdenum Spectrum

1. Complicated structure at 65–90Å seen
2. Highest ionization stages MoXXXII observed (i.e. – 1.72 keV)
3. Forbidden transitions of MoXV and MoXVI observed
(\textit{e.g.} 3d^{10} 3s_{2} 3p_{1} 1S_{0} - 3d^{9} 4s_{1} 3p_{3/2} 3D_{2} in the Ni-like MoXV at 57.92Å and 58.83Å)

Summary

• EUV spectrum from Mo and W investigated
• Carbon coated Mo and W wire injected into LHD plasma
• Molybdenum spectrum observed in 30–500Å
• Lines around 65-90Å identified and listed in table along with previous work
• Three blended spectrum bands observed for tungsten in 24-80Å
• Line spectra around 34Å identified as Δn=1 transition of WXXII–WXXVI having 4d^{10}4f^{2}–4d^{9}4f^{2}P_{5/2} and 4d^{10}4f^{2}–4d^{9}4f^{2}P_{3/2}, where k=3–7
• Isolated lines on top of the pseudo-continuum in 50-70Å identified as Δn=0 transitions of WXXVIII–XXX

Future study - Detail analysis on EUV spectrum below 50Å using an EUV spectrometer with better spectral resolution

References