TRitium Ion Implantation eXperiment (TRIIX) for Hydrogen Isotope Retention Measurements in Plasma Facing Materials

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Introduction

Tritium Ion Implantation eXperiment(TRIIX) [1,2] has recently been refurbished and is currently used in the frame of the US/Japan TITAN [3] collaboration to investigate deuterium(D) retention in plasma facing component (PFC) materials, in particular tungsten (W). This poster reports

1. The refurbished TRIIX and its capabilities
2. The validation results of its operation on W samples exposed to a D ion beam
3. The initial results of fluence dependence of D retention in W samples (A.L.M.T.Co) exposed to a D ion beam

TRIIX Overall Configuration

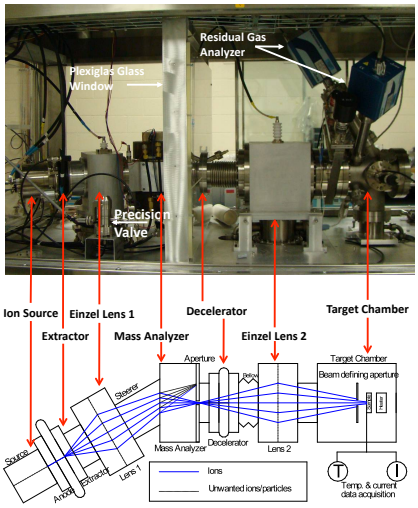

Fig.1: Overall view of implantation system (top) and schematics of ion optics (bottom)

Beam Defining and Diagnostics

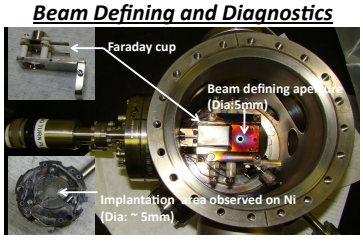

Fig. 2: Beam defining and diagnostic system

TRIIX Capabilities/Characteristics

- Beam energy: 0.3 ~ 10 KeV
- Beam flux density: 10^{18} ~ 10^{20} D/m²•s
- Beam size: 5mm (Dia.)
- Ion species: D for now and T in future
- Ion current on samples: real-time data acquisition
- Sample heating: up to 1000 °C and programmable
- Samples: non-radioactive and radioactive

Beam Characteristics: Flux density VS Energy

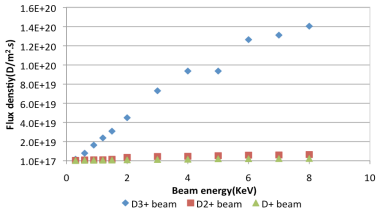

Fig. 3: D ion flux density for D, D_2^+ and D_3^+ beam

Validation Experiments on D flux density

Beam Energy (KeV)	D Flux Density(D/m²•s)	
	Current	Original
1.5	3×10^{19}	3×10^{19}
3	6×10^{19}	6×10^{19}

Validation Experiments on D retention

- Materials and methods
  - W foil with purity 99.5%, diameter 16mm and thickness 25 µm
  - Implantation: 1500 eV D_3^+ and 3×10^{23}D/m²
  - Target temperature: 100, 200 and 300 °C
  - Thermal desorption: 30 °C/min to 900 °C

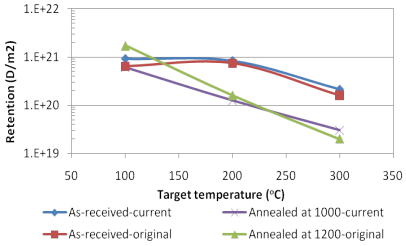

Fig.4: D retention in W foils implanted at target temperature of 100, 200 and 300 °C (Lines in Fig. 4 are for eye guidance only to show comparative trends)

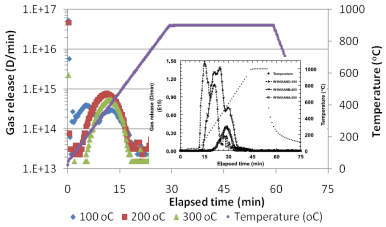

Fig.5: D desorption spectra of as-received W foils implanted at 100, 200 and 300 °C from the validation experiment and original data reported in [2]

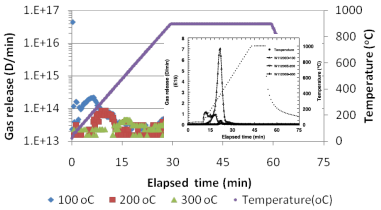

Fig.6: D desorption spectra of W foils (annealed at 1000 °C and 1200 °C) implanted at 100, 200 and 300 °C from the validation experiment and original data reported in [2]

Fluence Dependence of D retention in W

- Materials and methods
  - W (A.L.M.T.Co) discs with purity 99.99%, diameter 6mm and thickness 0.2mm; annealed at 900 °C for 30 mins
  - Implantation: fluence 10^{22-24} D/m² @ 1500 eV D_3^+ and target temperature 200 °C
  - Thermal desorption: 30 °C/min to 900 °C

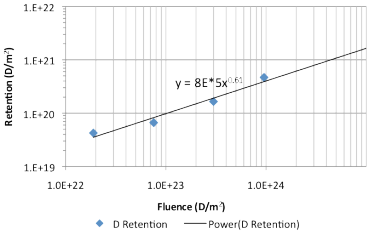

Fig. 7: Fluence dependence of D retention in W

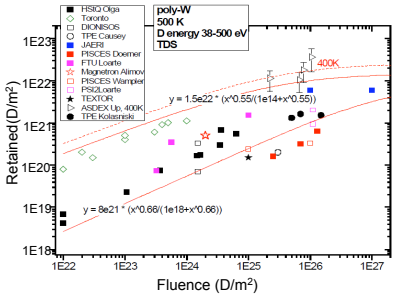

Fig. 8: Reference data for retention of implanted D in W[4]

Results and Summary

- Validation experiments on the operation of the refurbished TRIIX show
  1, D retention and temperature dependence of the as-received W foils matched closely with the original data in [2]
  2, The validation experiment D desorption peak temperature did not exactly match the temperature data reported in [2]
  3, The inconsistency of desorption peak temperatures could be attributed to no liquid nitrogen cooling on sample holder following implantations and the different settings utilized in thermal desorption experiments
- The fluence dependence of D retention in the W samples shows the retained amount of D is proportional to the incident fluence to the power of 0.61; further SIMS/NRA need to be performed to investigate D depth profile in W samples.

Acknowledgment

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References

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