Max-Planck-Institut
für Plasmaphysik

Determination of the sticking coefficient of low-energy hydrocarbon ions

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Materialforschung

Motivation

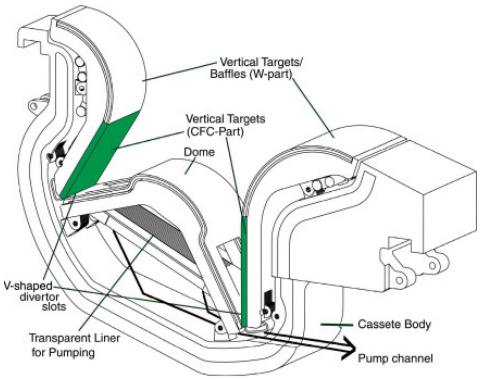
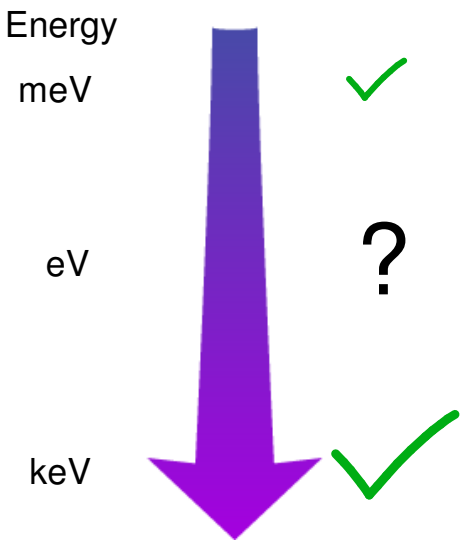


Image from ITER Technical Basis

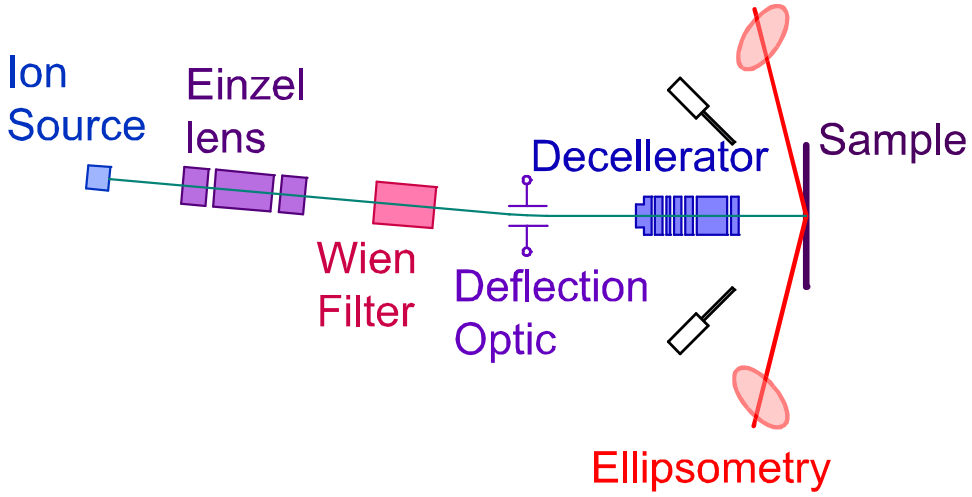
- Carbon in ITER Divertor
  - Erosion
  - Redeposition
    - Tritium codeposition
    - Predictions very uncertain

Deposition Mechanisms and Energy Scales



- Very low energy (meV)
  - Chemisorption
  - Accessible with
    - Thermal radicals
    - MD Simulations
- Low Energy (eV)
  - ???
- High energy (keV)
  - Implantation
  - Physical Sputtering
  - Accessible with
    - Laboratory Experiments
    - Binary Collison Approximation (TRIM, TRIDYN)

Experimental Setup



Selection of Target Material

- Model system for first wall
- Plasma deposited amorphous hydrocarbon (hard a-C:H) layer on silicon

- Transparent
  - Thickness is accessible via ellipsometry
  - Optical constants stable and well known

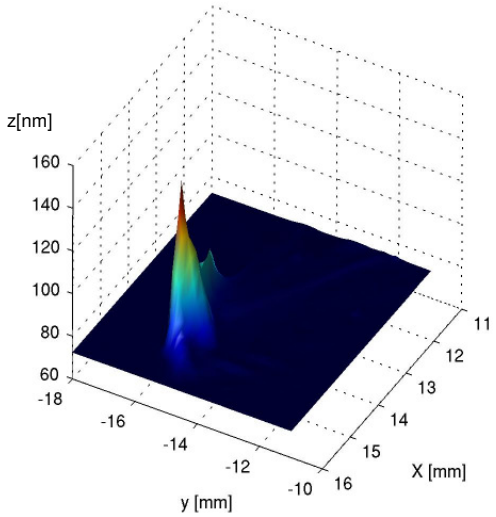
- Grows after initial nucleation phase independent of substrate
  Steady-state growth can be observed

First Experiments and Results

- 24 hours, 150 eV, CH_x^+

- Sticking coefficient ~1
  Measured by
  - Determining volume of grown layer and
  - Integrating over current on sample

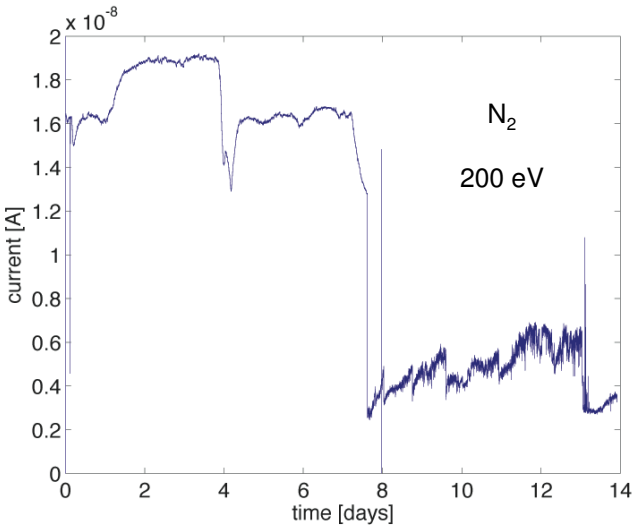
- Grown layer is visible with naked eye



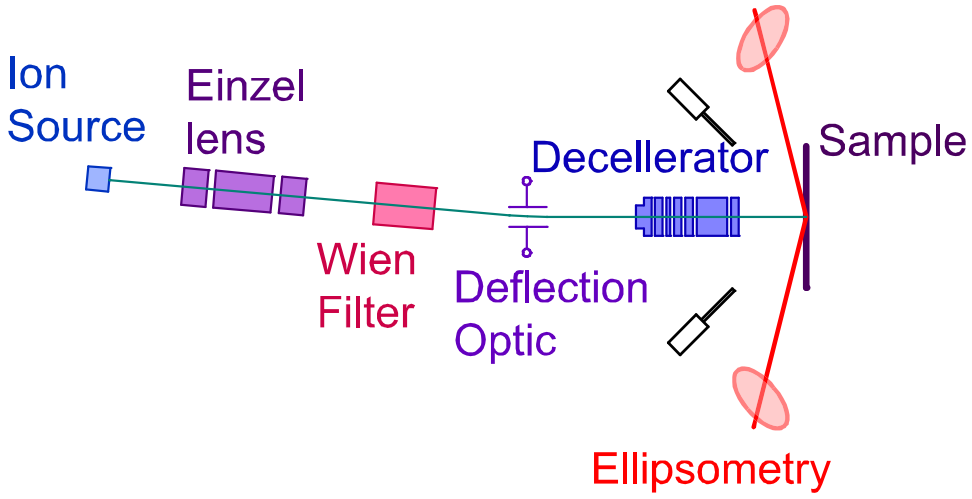
Experimental Challenges

- Very low fluxes
  - ~10^{10}/s on an area of ~ 3 mm^2 at 150 eV
    ~ 150 s per monolayer
  - Even lower fluxes at lower energies
  - → Experiments run for several days
- Ion source unstable

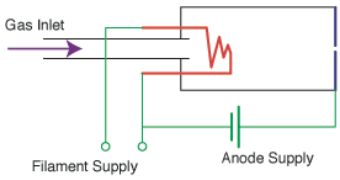
Current on Target over Time



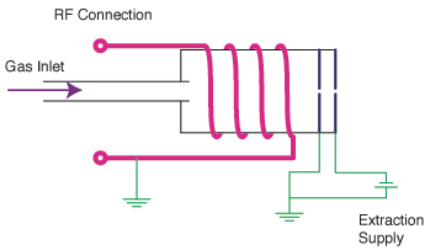
Experimental Setup



Ion Source Improvements

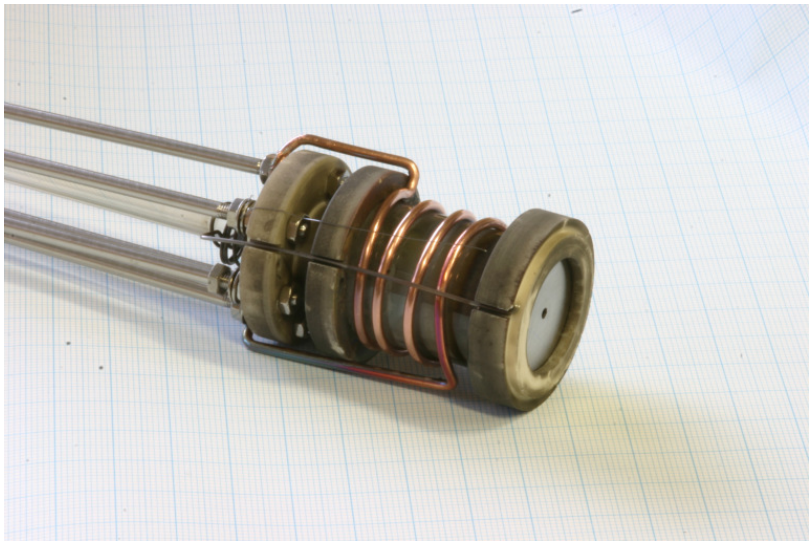


- Old source
  - Hot filament
  - DC-Discharge



- New source
  - Inductively coupled RF plasma

New RF Ion Source Prototype



Summary

- Sticking coefficient is an important parameter to experimental fusion devices
- The sticking coefficient of different CH_x (x=1...5) shall be determined in the energy range from 10 to 200 eV
- To improve ion beam current and stability, a new ion source is under development