Plasma-Assisted Synthesis of Molybdenum Carbide Catalysts

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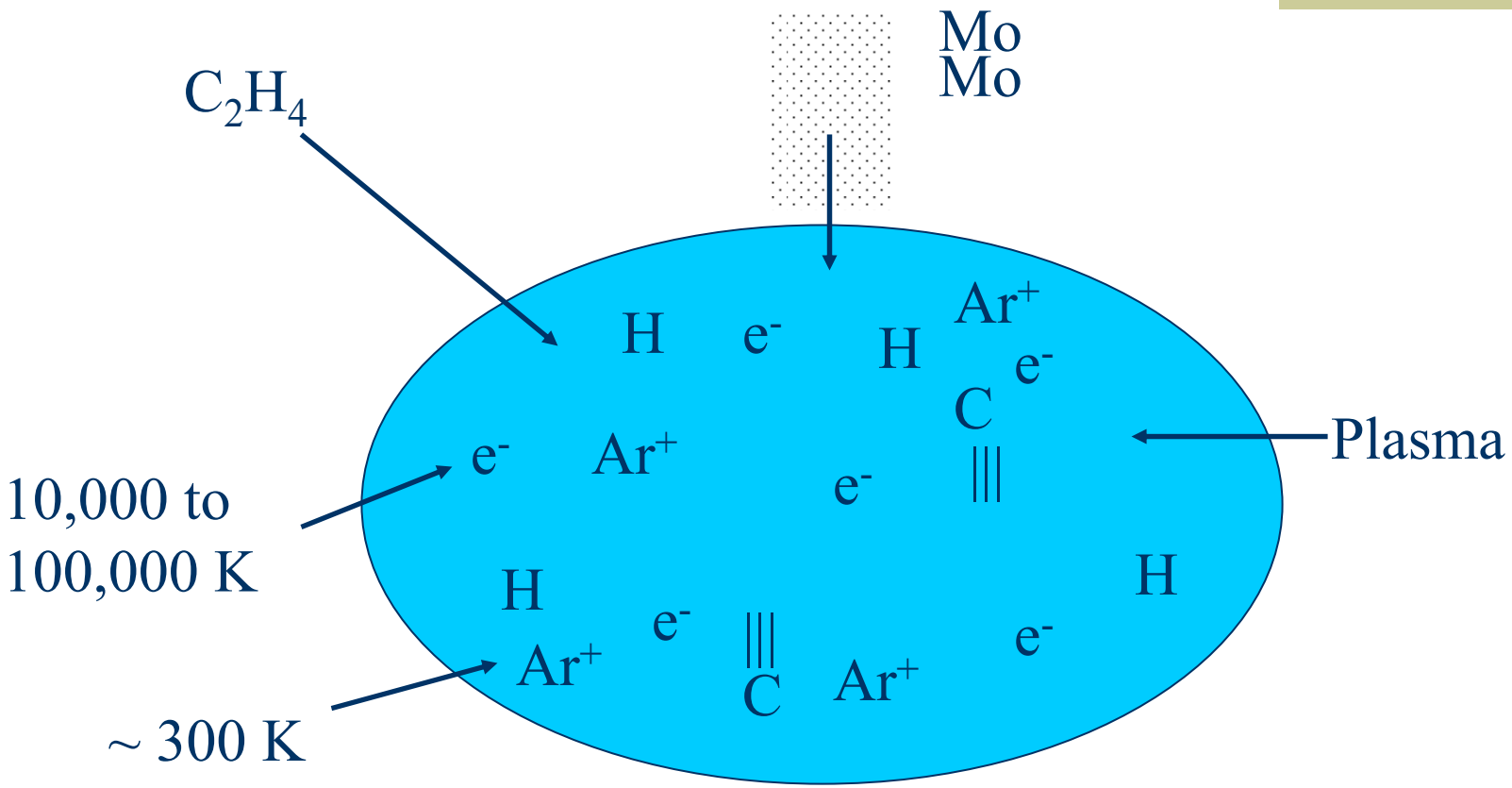
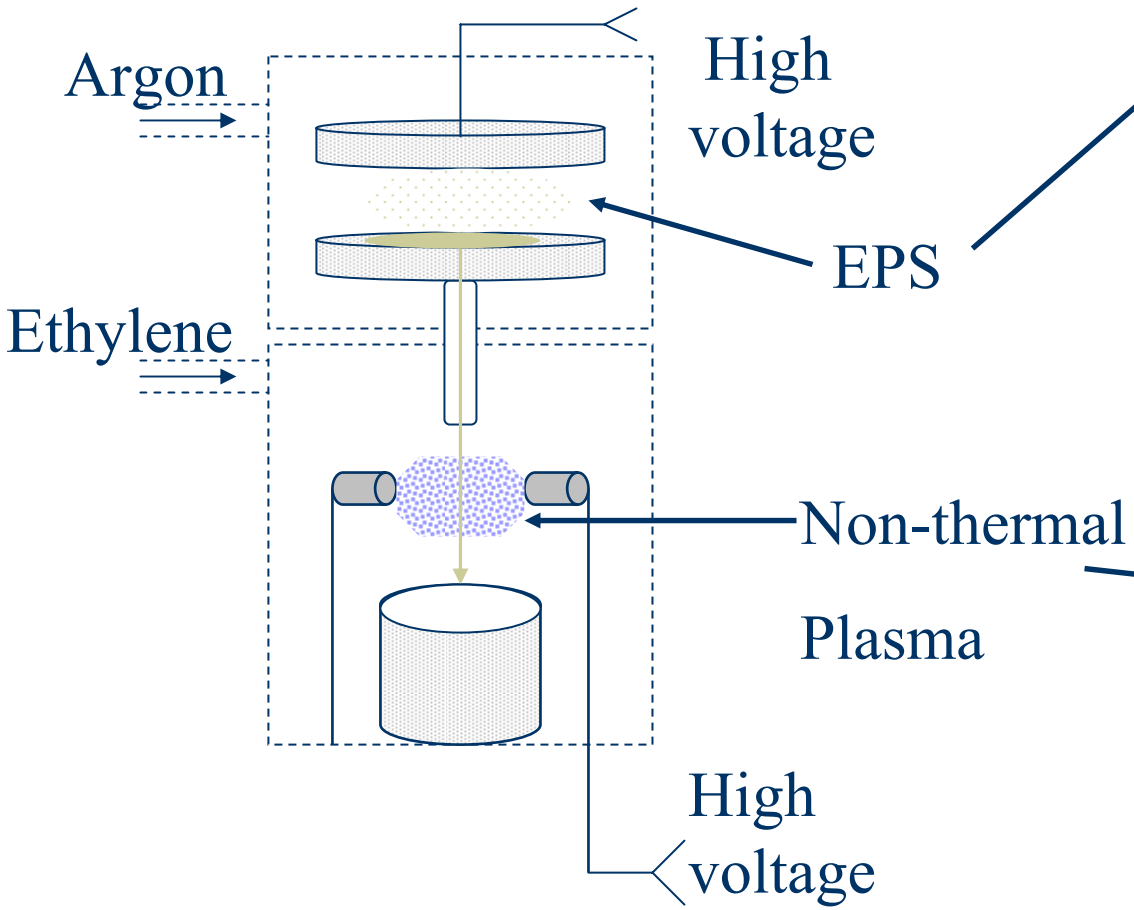
Purpose & Motivation

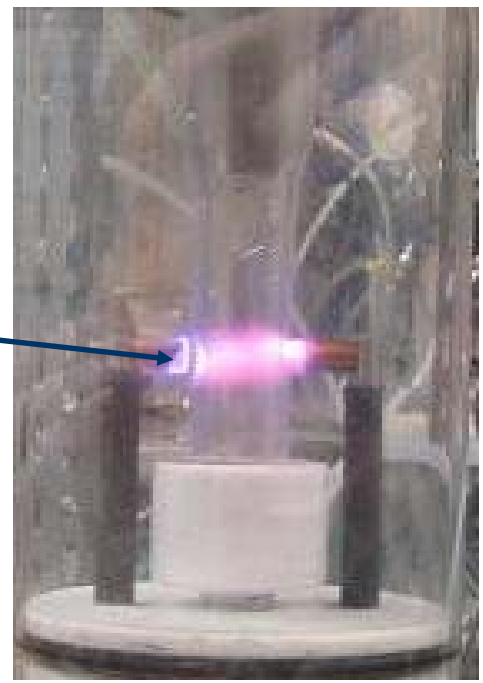
- Trying to find effective & efficient method to create Mo_2C
- Mo_2C can replace expensive precious metal catalysts
- Cheaper & more efficient
- Water-Gas Shift Reaction (WGS)
  - $CO + H_2O \rightarrow CO_2 + H_2$
  - Fuel cell applications
- Main Objectives
  - Study the parameters of the reactor
    - Make the reactor more efficient
    - Vary the concentration of ethylene

Chemistry Behind Forming MoC



Two-Chamber Reactor



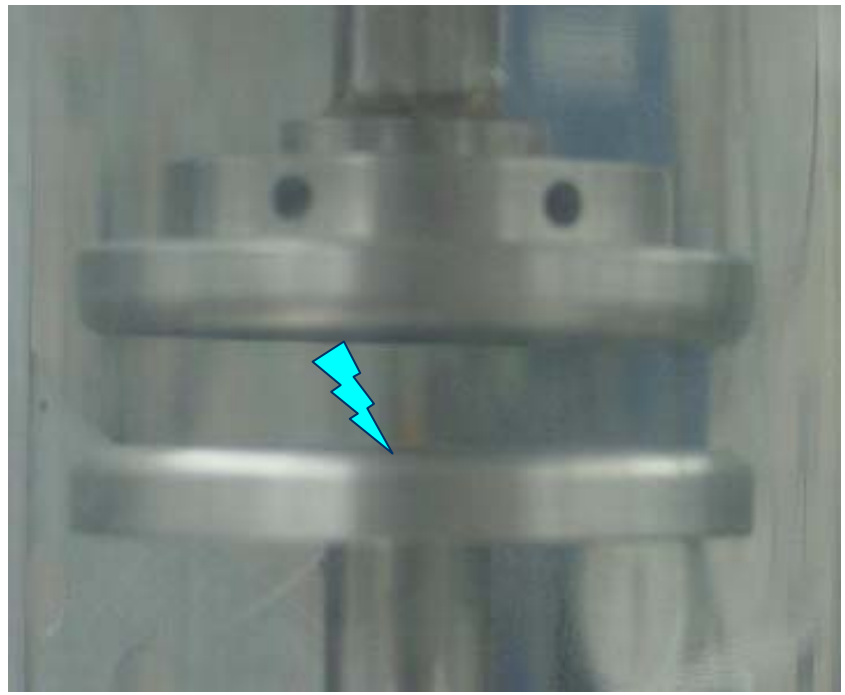


Changes to Make the Reactor More Efficient

- Main concern: not collecting enough particles
  - ~15% yield
- New filters
  - 40 to 26 micron
  - Mo = 44 micron
- New part to close gap

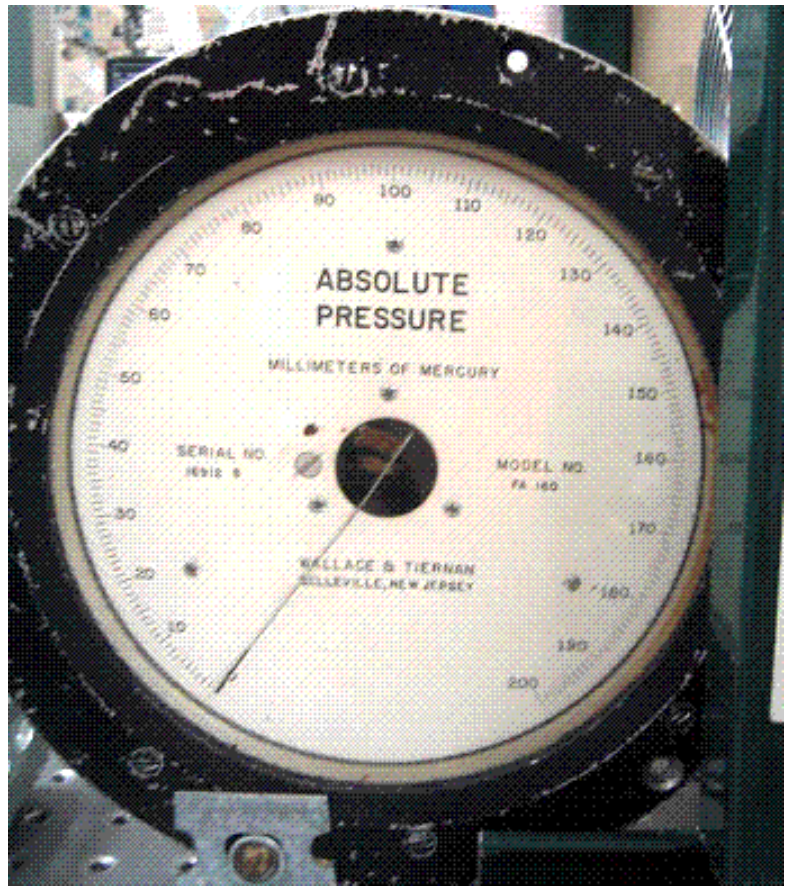
Changes to Make the Reactor More Efficient

- **Problem:** breakdown occurring between top plates
  - when putting in ~1 g, yield ~0.15 g
- **Solution:** add ½ gram of Mo powder instead of 1 gram



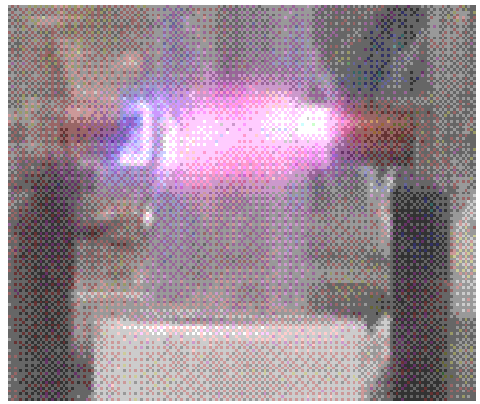
Changes to Make the Reactor More Efficient

- **Problem:** lowest vacuum pressure ~4 torr
  - Possible leak in system, letting in air
- **Solution:** reseal all connections
  - Pressure decreased to approx. Ø torr

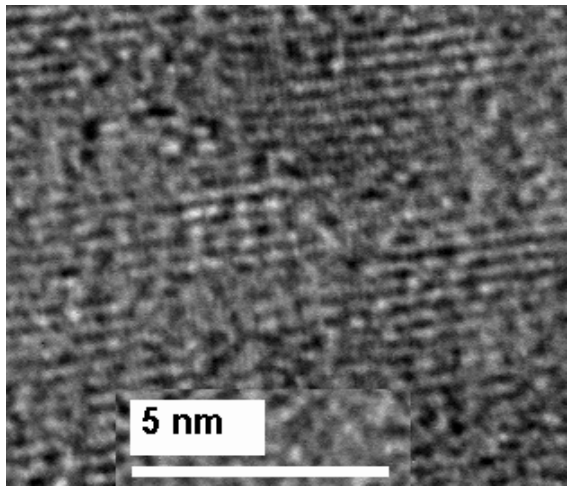


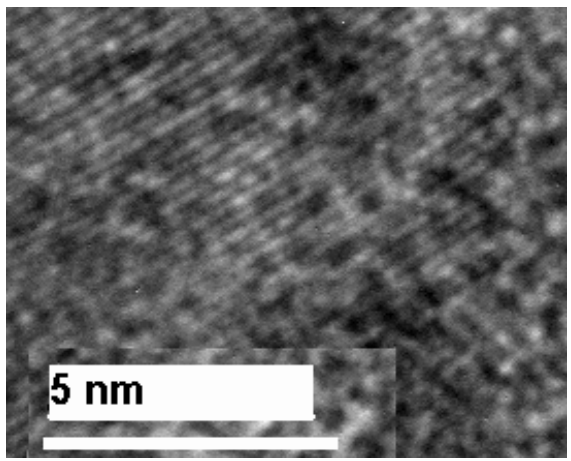
Results of Solutions

- Collecting more mass
  - Old system: 15% yield
  - New system: 30-51% yield
- Plasma color
  - From pink/orange to bright blue



Analysis of Reacted Mo Particles: TEM

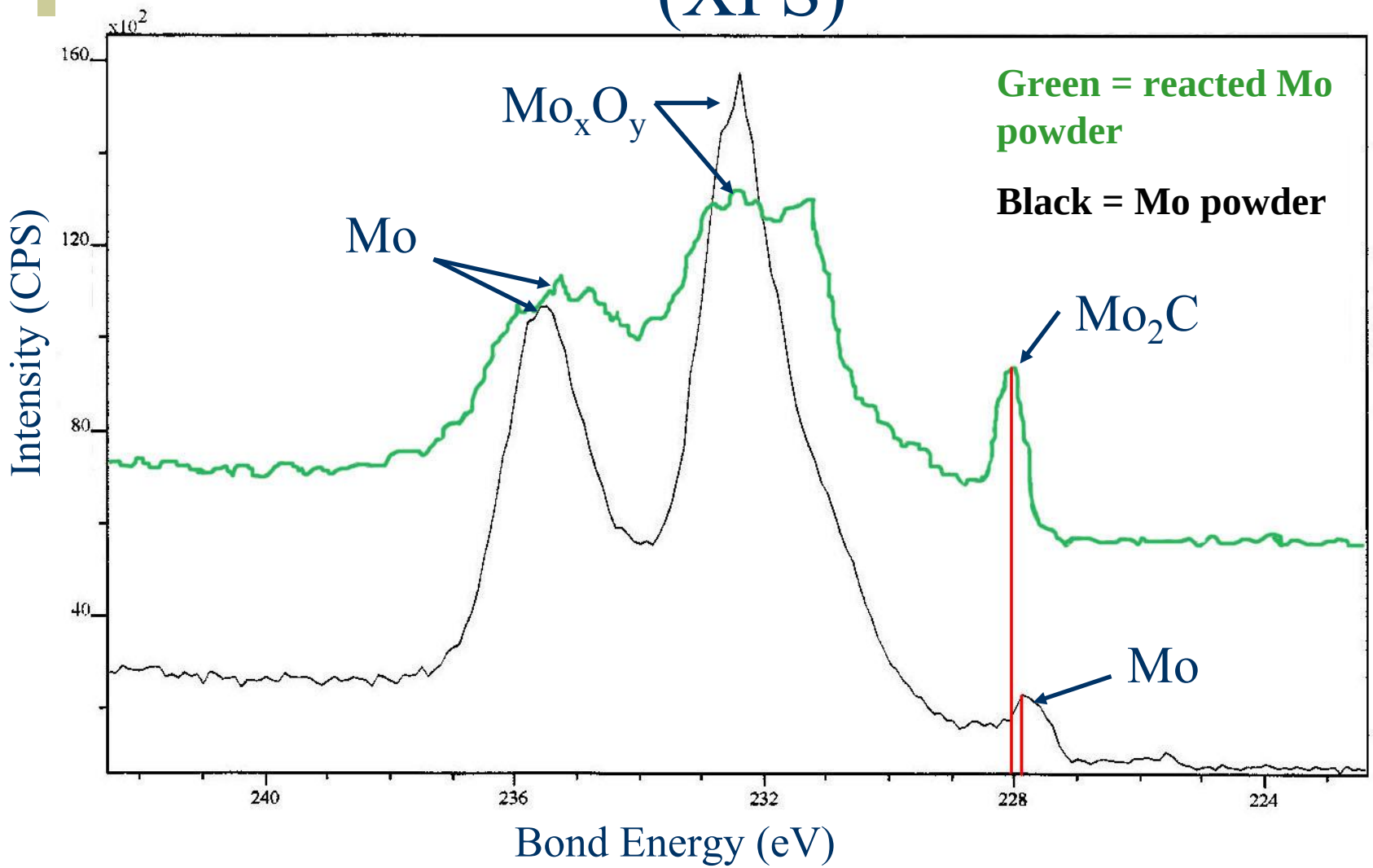




- Transmission Electron Microscope (TEM)
- Can show d-spacing
- Each compound has unique length

• Top Picture	•Bottom Picture
2.77 ± 0.06 Å	2.18 ± 0.02 Å
MoC = 2.74	MoO_2 = 2.18

Analysis of Reacted Mo Particles: X-ray Photoelectron Spectroscopy (XPS)



Conclusions

- The reactor is creating MoC, Mo_2C
- May or may not be creating MoO
  - TEM
  - XPS
- System modifications provided higher % yield
  - From 15% to 30-51%
- Over small range of ethylene, no significant change

Future Work

- One chamber reactor
- Clean with H_2 to remove oxides
- Use silver tape instead of carbon for XPS
- More XPS analyses
- Test catalytic activity with water-gas shift reaction

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