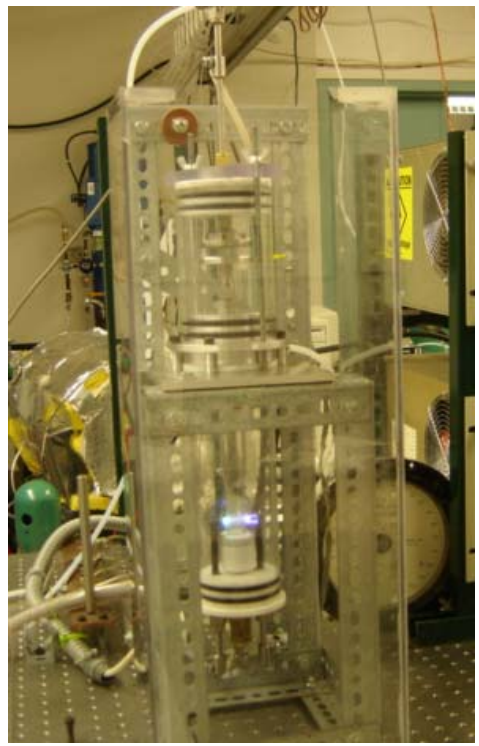
Plasma-Assisted Synthesis of Molybdenum Carbide Catalysts

Geoff Campbell

Kellee Nelson

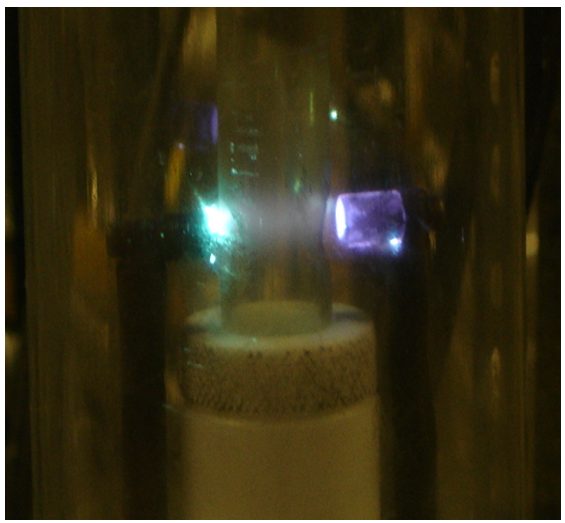


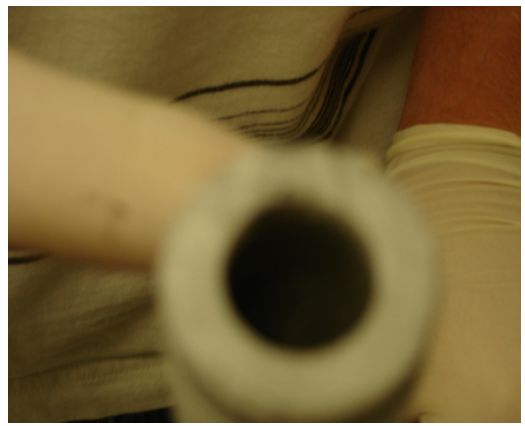
RET: Cheryl Heitzman

Advisors: Profs. Brezinsky and Saveliev

Purpose

- To optimize the plasma-assisted method of synthesizing MoC thin films

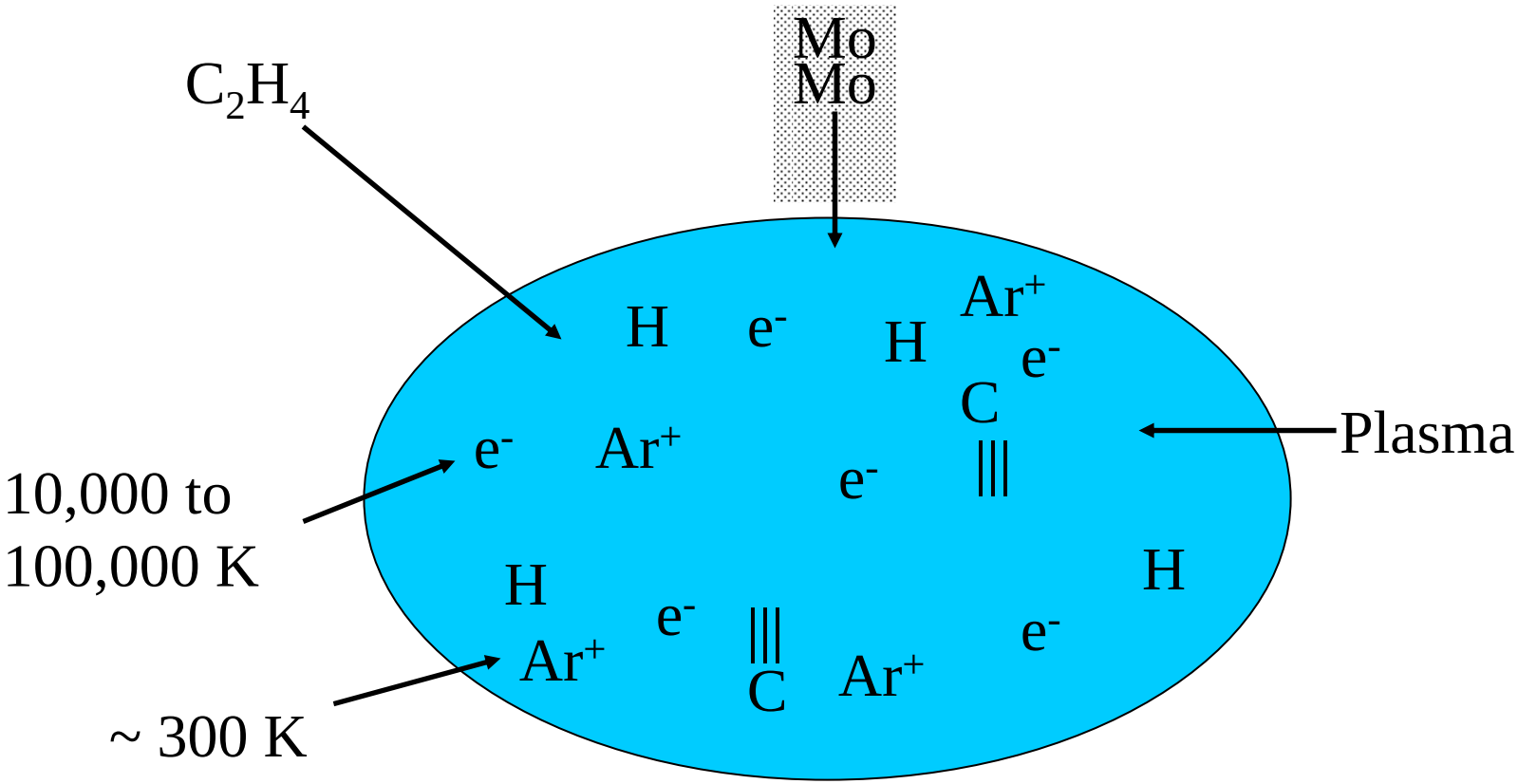


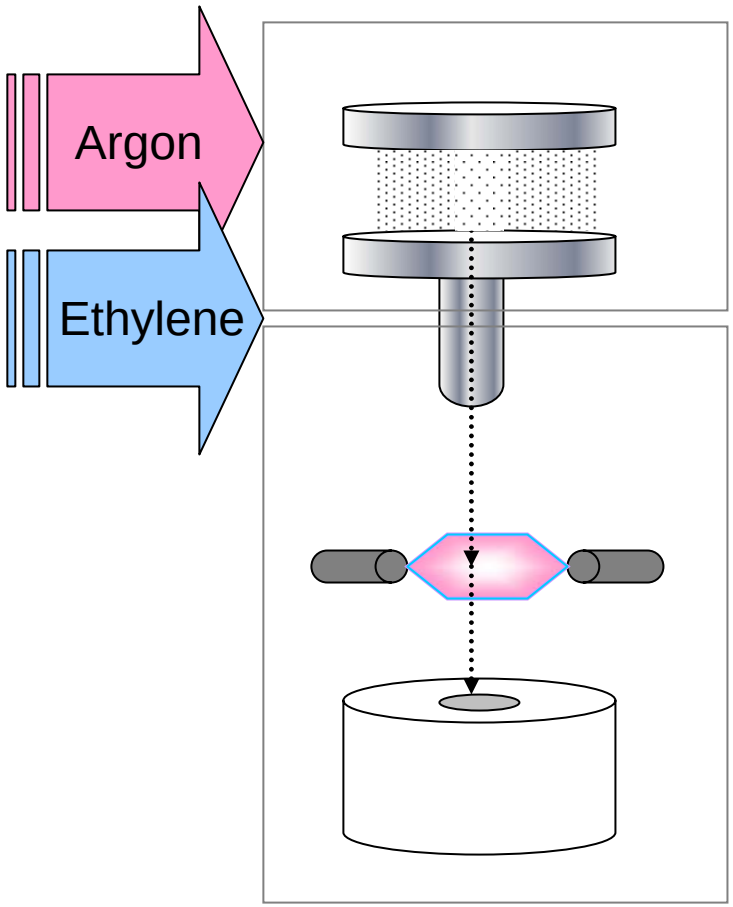


Motivation

- **Cheaper** – MoC can replace expensive precious metal catalysts
- **More efficient** – Displays a higher tolerance to sulfur and nitrogen
- **Fuel cell applications**
  - Water-Gas Shift Reaction (WGS)
  - $CO + H_2O \xrightarrow{\text{catalyst}} CO_2 + H_2$

Chemistry Behind Forming MoC





Top Chamber

Electrostatic Particulate Suspension

Bottom Chamber

Plasma Generation

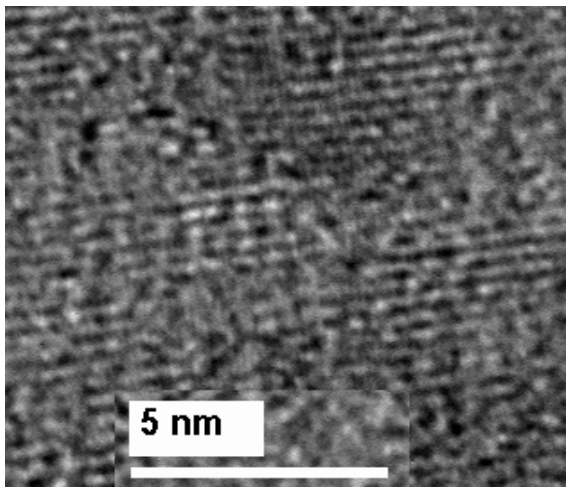
- **EPS** on
- **Power** given to the Bottom Chamber
- **Argon** and **Mo** sent from Top Chamber to Bottom Chamber

Pink Plasma formed

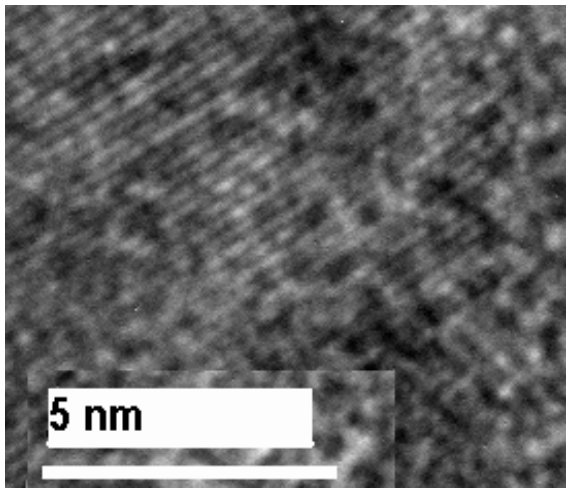
- **Ethylene** sent to Bottom Chamber
- **MoC** to be collected in Filter

Blue Plasma formed

Analysis with TEM

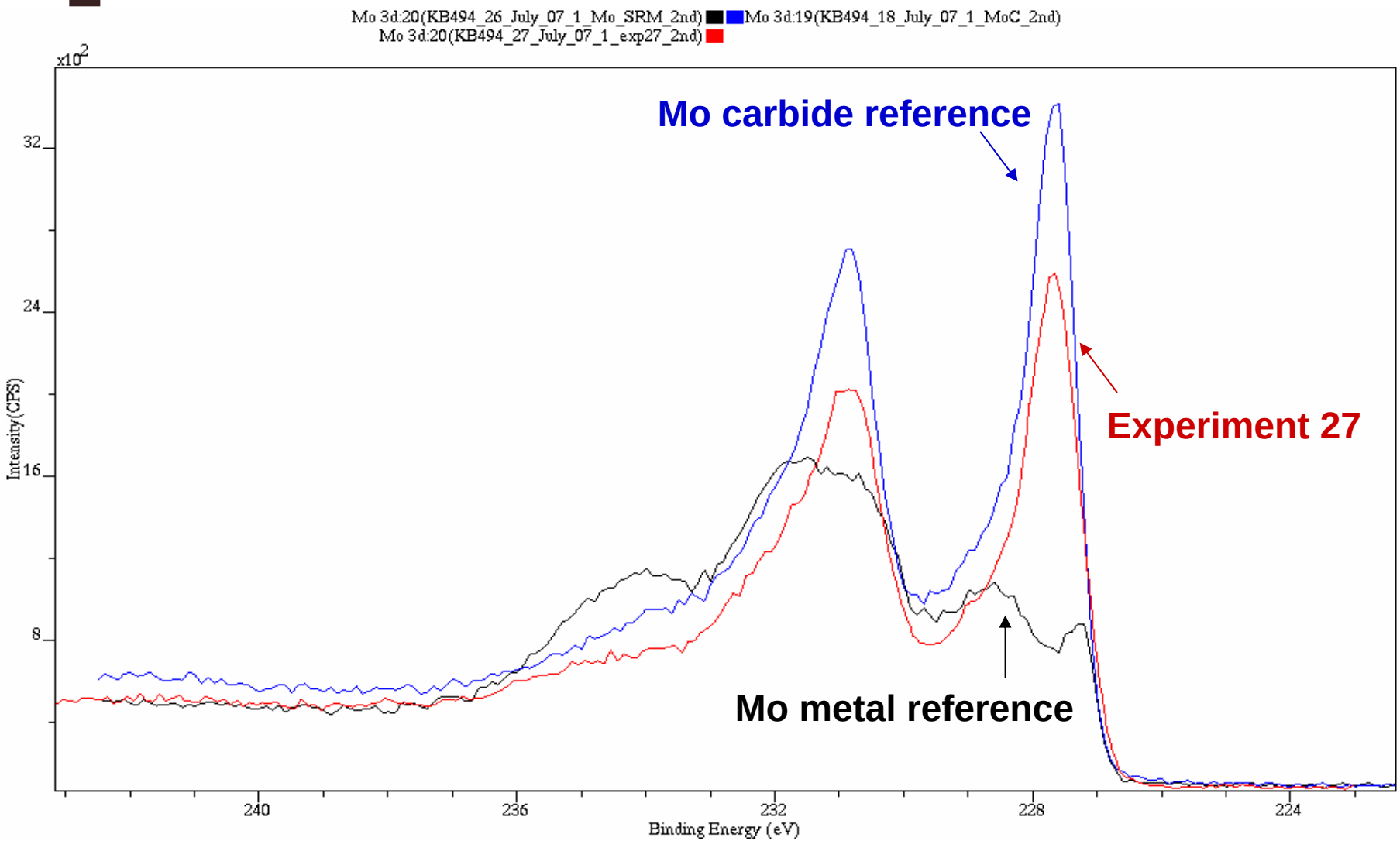


- Transmission Electron Microscopy (TEM)
- Can show d-spacing
- Each compound has unique length

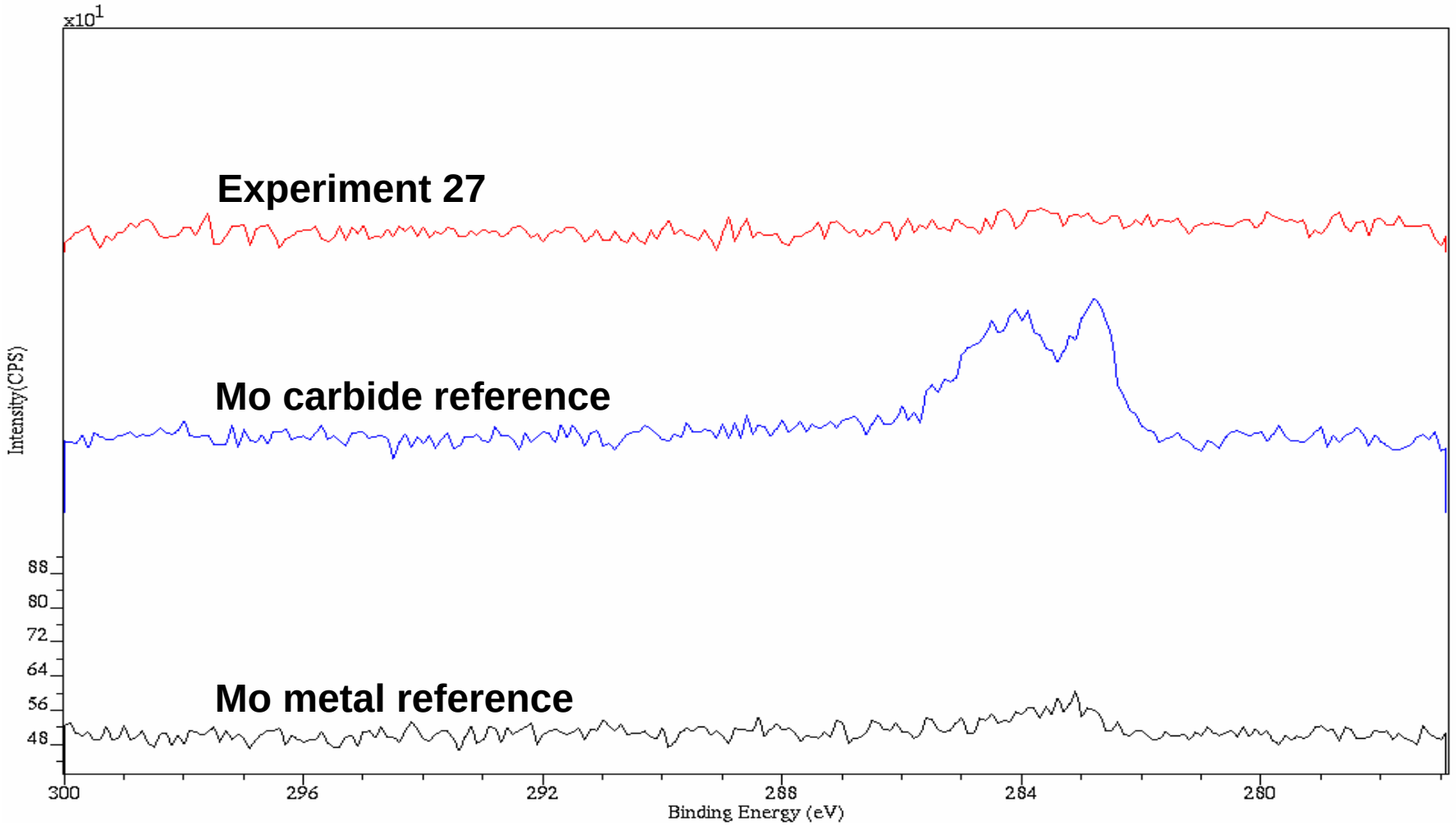


• Top Picture	•Bottom Picture
2.77 ± 0.06 Å	2.18 ± 0.02 Å
MoO_2 = 2.74	MoC = 2.18

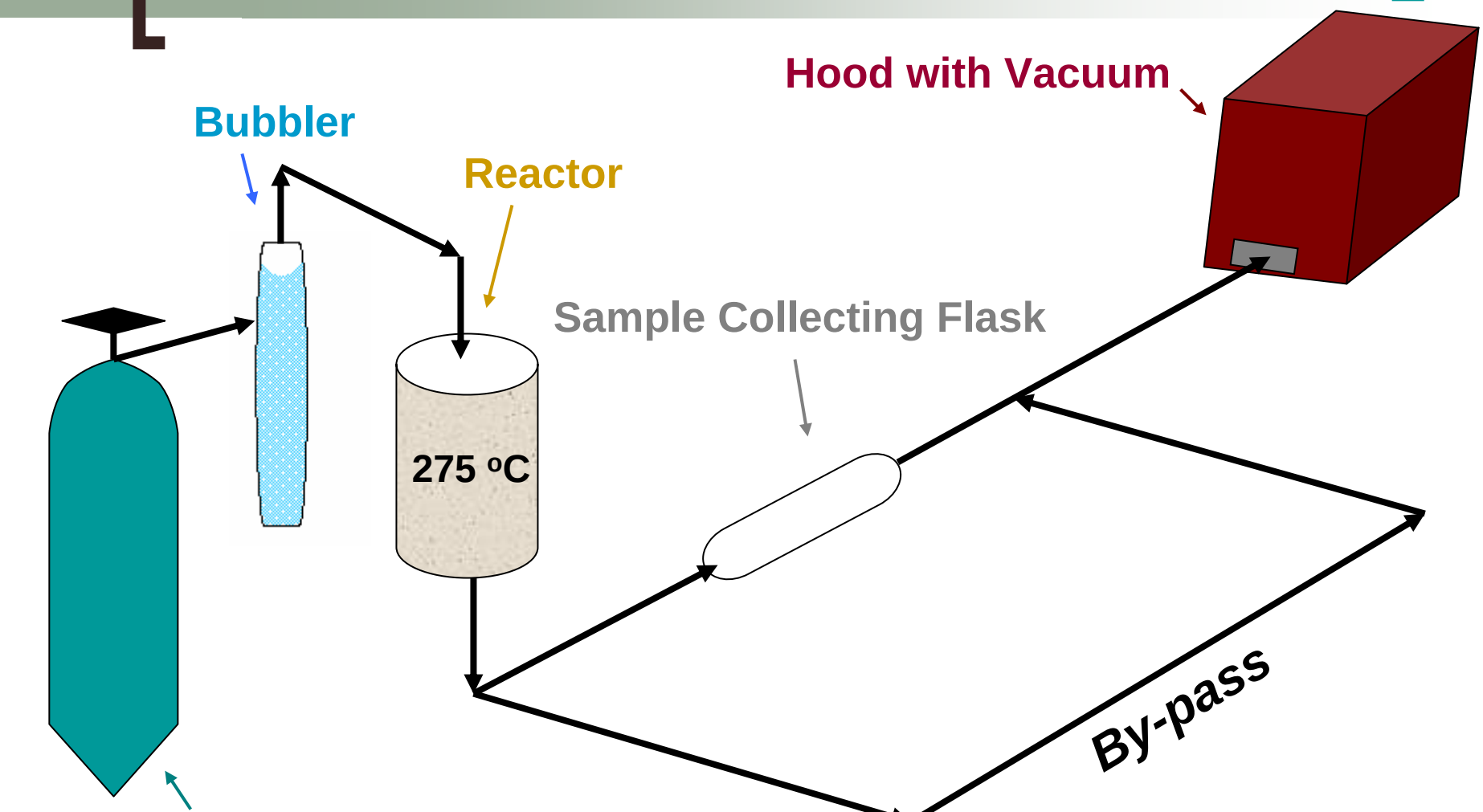
Analysis with XPS: Mo-3d



Analysis with XPS: C-1s



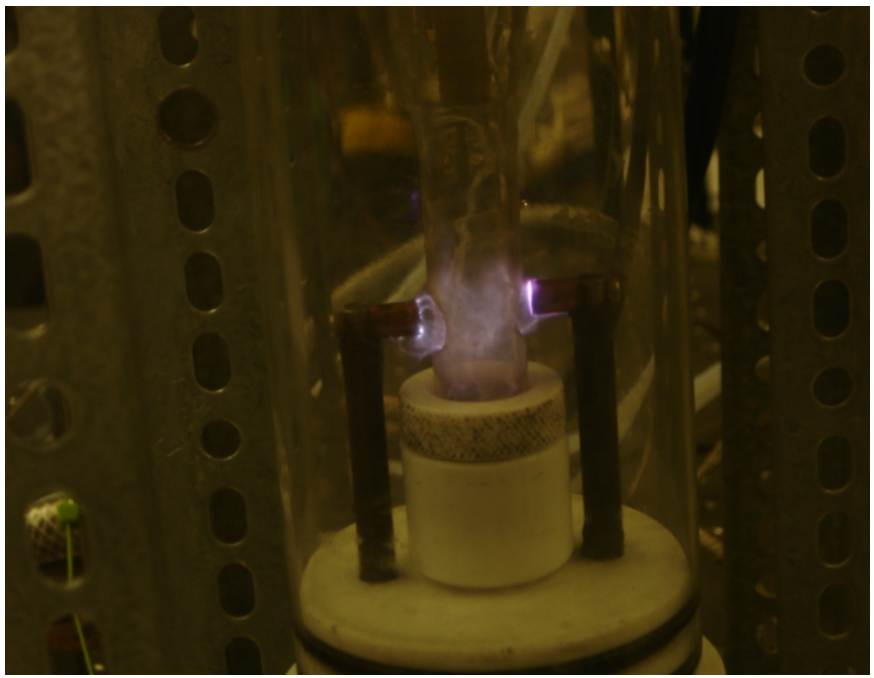
Water-Gas Shift Reactor

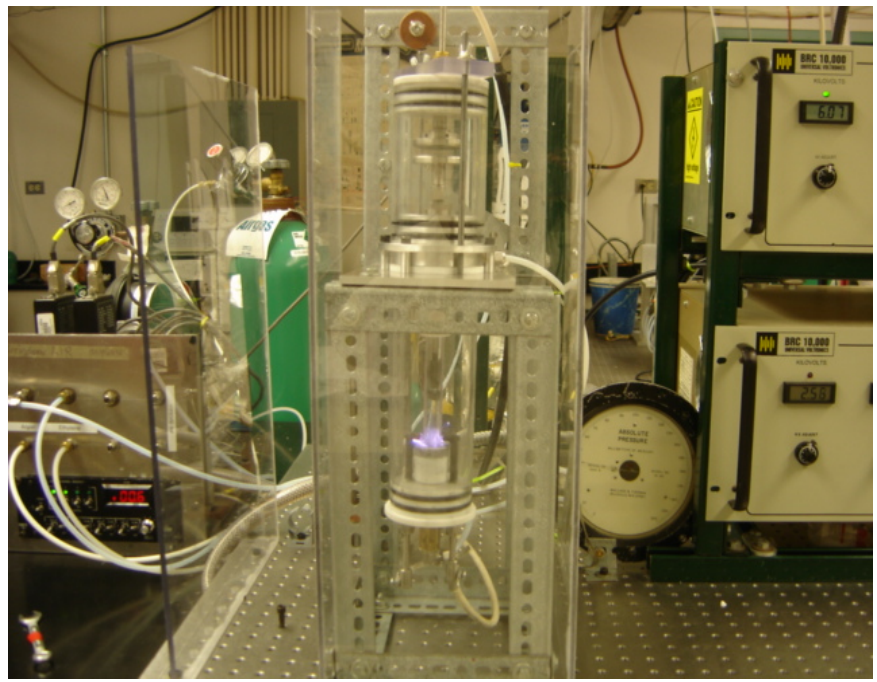


$$CO + H_2O \xrightarrow{\text{catalyst}} CO_2 + H_2$$

Achieved Objectives

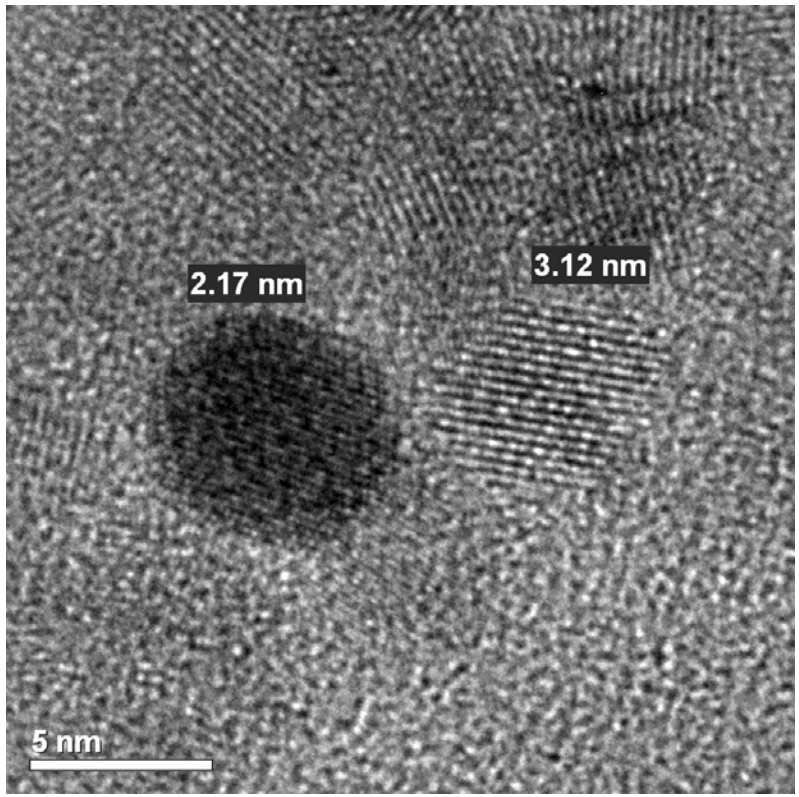
- ✓ Found best TEM results with low ethylene concentrations
- ✓ Increased yield of apparatus from 25% to 50%
- ✓ Tested a sample in the WGS reactor





Future Work

- Reduce the amount of MoO formed
- Test more products with the WGS reactor and XPS



Thank you!

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and

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- **Cheryl Heitzman**

- **Everyone in:**
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  - Micro/Nanoscale Fluid Laboratory
  - Catalyst Laboratory
  - Research Resource Center
  - Machine Shop
  - Glass Shop

Questions