Status of Top Seal Development

M.E. Kupfer, Dean Walters, A.G. Raraz,
and J.E. Indacochea

April 26, 2011

JSAMRL
Joining Science and Advanced Materials Research Laboratory

Sealing Success

Indium Alloy	Coatings (sidewall-window)	Bonding Temperature, °C	Pressure, Psi (MPa)	Leaking test, std cc/sec
In-Sn (100 µm)	Silver-Silver	120 (above m.p.)	800 (5.5)	Background: 5×10^{-10} Max. leak: no leak
				Background: 3.9×10^{-9} Max. leak: no leak
				Background: 7×10^{-9} Max. leak: leak
				Background: 7×10^{-9} Max. leak: leak
	NiCr-NiCr	120 (above m.p.)	800 (5.5)	Background: 2×10^{-9} Max. leak: no leak
				Background: 3.5×10^{-7} Max. leak: leak
In-Bi (100 µm)	NiCr-NiCr	80 (above m.p.)	800 (5.5)	Background: Leak Max. leak: Leak

All seals made in air

What has been working

- **Temperature**
  - Melting the filler material works while thermocompression has not worked. (Oxide layer?)
  - Holding temperature for too long produces “spots” on silver layer. (Intermetalics?)
- **Pressure**
  - Pressure is required to break oxide layer, but the 5.5 MPa is excessive for solder seals.
  - Solder is being squeezed out.

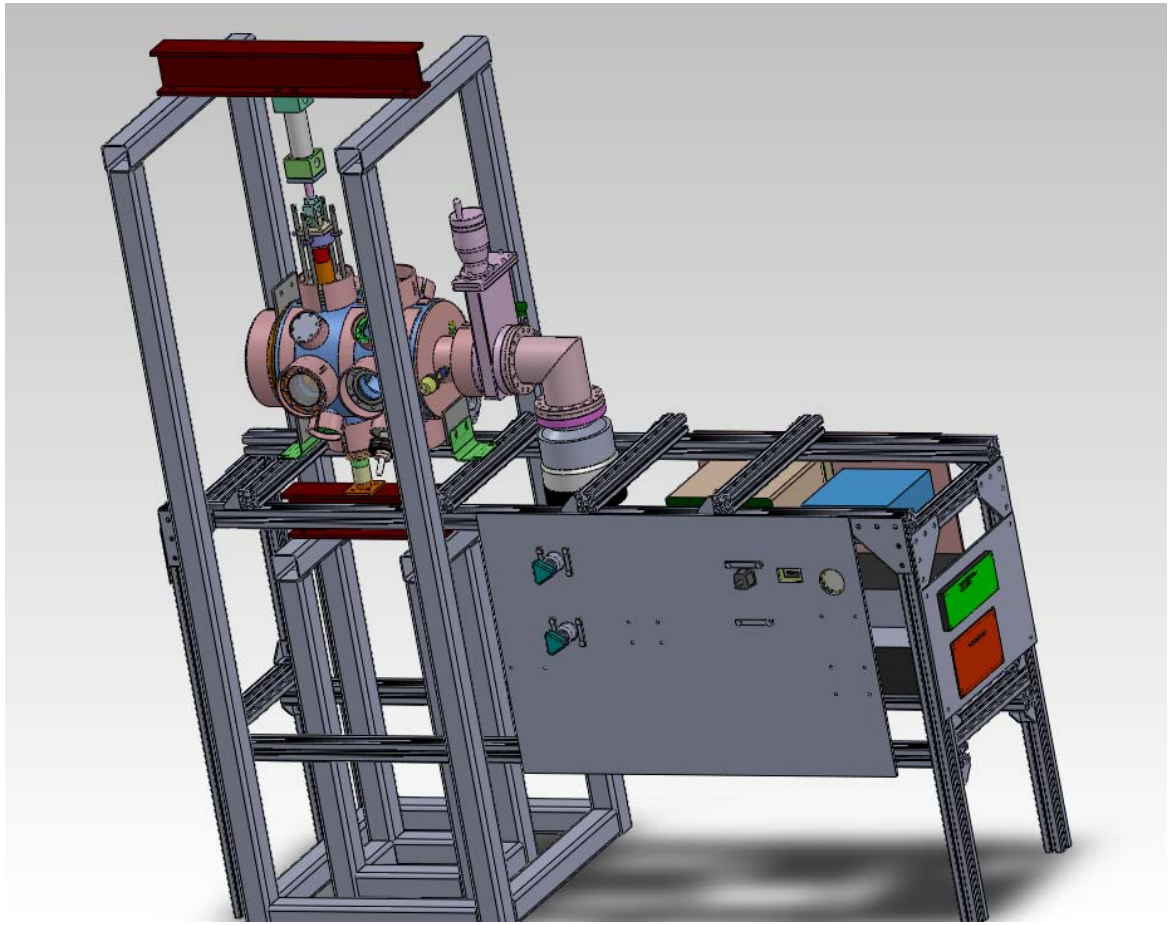
What has been working

- **Vacuum**
  - Samples produced in air may have trapped volumes of air. (If indium is not melted)
  - Leak tight seals have been made in air, so why not in vacuum?
- **Tie Layer**
  - Leak tight seals have been using both silver transfer tape and Nichrome.
- **Indium Alloys**
  - In52/Sn48 : T_M = 118ºC – Only successful as a solder.
  - In66/Bi34: T_M = 72ºC – Unsuccessful to date.
    - Some good background leak test results, but seals still have leak. Problem with porous silver layer?

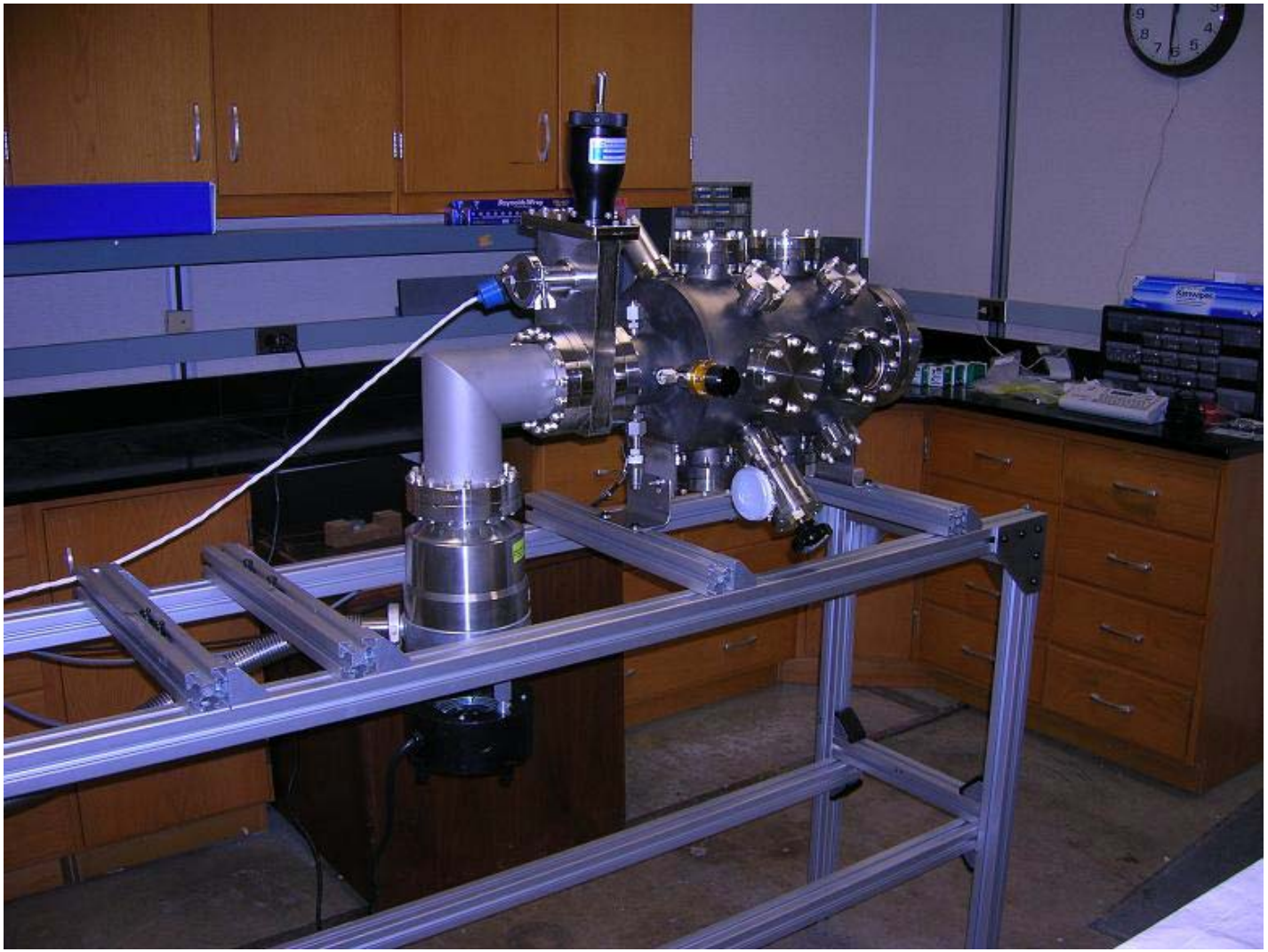
Next Steps

- **Sealing in vacuum**
  - Finish design and construction of vacuum chamber
  - Optimize parameters
- **How and when to apply indium**
  - Preformed foil
  - Wire
- **Removal of oxide layer on foil**
  - Melt and scrape
  - Hydrogen/Methane
  - Acid

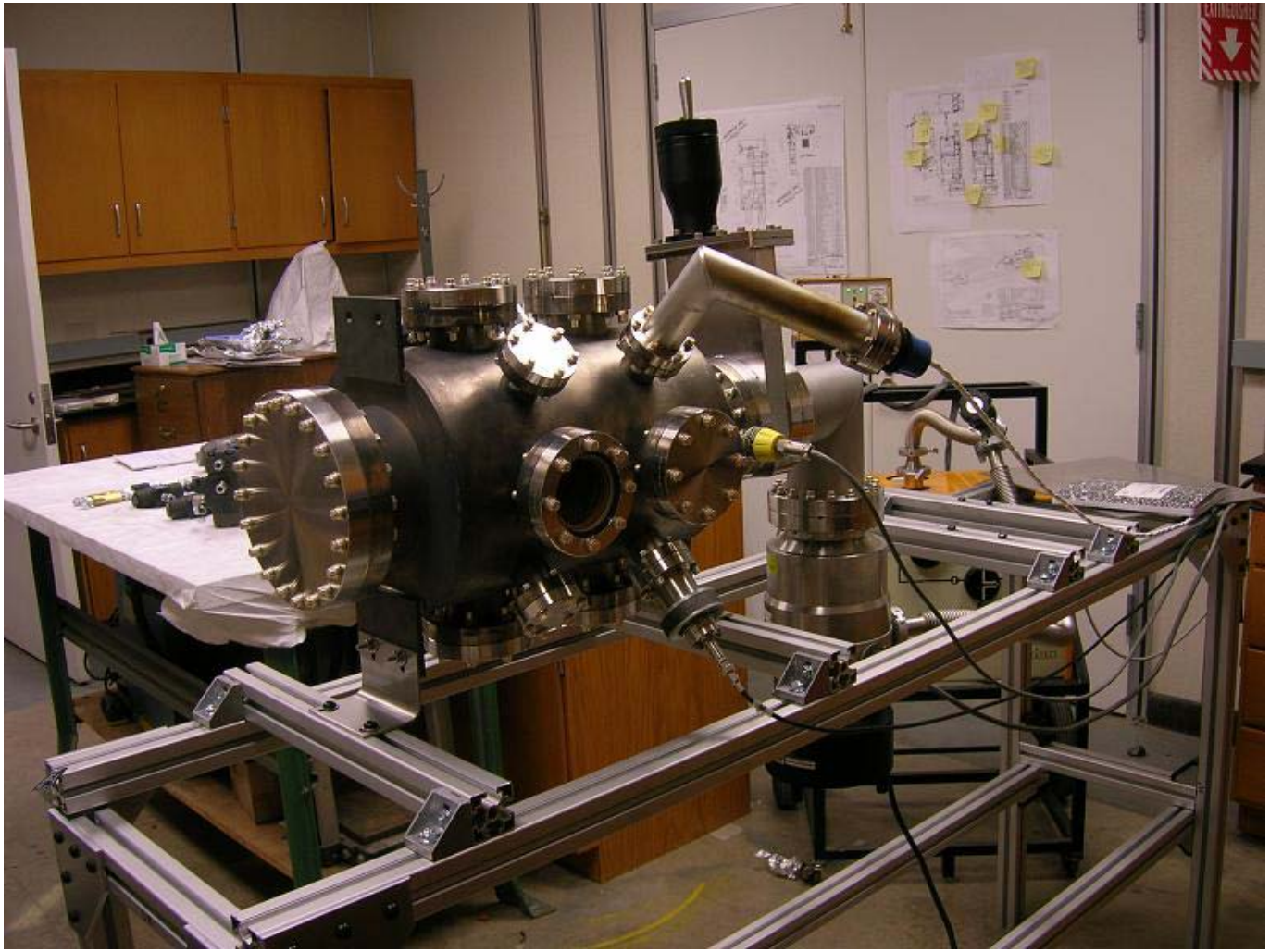
Vacuum Chamber



Vacuum Chamber



Vacuum Chamber



Vacuum Chamber

- Pressures on the 10^{-7} scale and lower
- Radiation heating for +300ºC
- Designed for 3500 pounds of pressing force
- Chamber can fit up to 4” tile as-is
- Quick-release door for rapid testing

Phases of Progress

- Phase 0 – Vacuum
  - Current
  - Roughing and turbo pump
  - All gauging and controls operational
- Phase 1 – Heating Only
  - Early May
  - Installation of internal bulb heaters, external flange heaters, thermocouples, and temperature controls
  - Able to make seals using a dead load
- Phase 2 – Heating and Pressure
  - Mid June
  - Load frame constructed
  - Hyrdaulic cylinder and all valves/controls installed

Future Improvements

- Hook-ups to nitrogen and argon
  - If hydrogen/methane cleaning seems feasible, hook-ups for those as well
- Data acquisition using LabView software