Low Temperature Top Seal for the LAPPD Project

Dean Walters
Bob Wagner
Argonne National Laboratory

Marc Kupfer
J. Ernesto Indocochea
Alcides Raraz
University of Illinois - Chicago

Direction of Seal Development

- There are two main directions
- Direction #1 Solder type seal
- Direction #2 Compression Seal

Solder Seal

Soldering Technical Information

- In52/Sn48 alloy has a m.p. of 118° C.
- In66/Bi34 alloy has a m.p. of 72° C.
- Vacuum soldering: 10^{-6} Torr.
- After soldering tests, samples were leak tested to evaluate sealing quality.
- No pressure was applied during bonding.

Solder

Preliminary Leak Test Results

Filler Alloy (thickness)	Sidewall	Window	Temperature	Leak Test, std. cc/s He
In52/Sn48 (50µm x 2)	Ag	Ag	127	Background: 10^{-8} Max Leak: 10^{-7}
			127	Background: 6.3×10^{-8} Max Leak: leak
	Ag	NiCr	128	Background: 2.0 x 10-9 Max Leak: 2.3 x 10-7
	NiCr	NiCr	126	Background: 2.6×10^{-9} (*) Max Leak: 7.5×10^{-8}
			129	Background: 1.5×10^{-8} Max Leak: 2.0×10^{-7}
			128	Background: 8.5×10^{-10} Max Leak: 2.0×10^{-8}
	Glass	Ag	127	Background: 2x10-9 (*) Max Leak: 3x10-7
	Glass	Glass	127	Background: 2x10-9 (*) Max Leak: 2.3x10-7
66In/34Bi (100µm)	Ag	Ag	76	Background: 6.3x10-8 Max Leak: Leak
			76	Background: 1.6x10-8 (*) Max Leak: 10-5
			75	Background: 1.2x10-9 Max Leak: 2x10-7
			75	Background: 2.4x10-9 Max Leak: 1x10-6

- General Baseline: 8×10^{-10} std. cc/s Helium
- (*) Baseline may have been closer to 1.5x10-9
- NiCr layer is approx. 20 nm thick.

Solder

Appearance of Silver Layer

- 66In/34Bi
- Formation of discolored patches at silver-glass interface.
- Intermetalics? Oxides?

- 52In/48Sn
- Lesser formation of discolored patches.
- Intermetalics? Oxides?

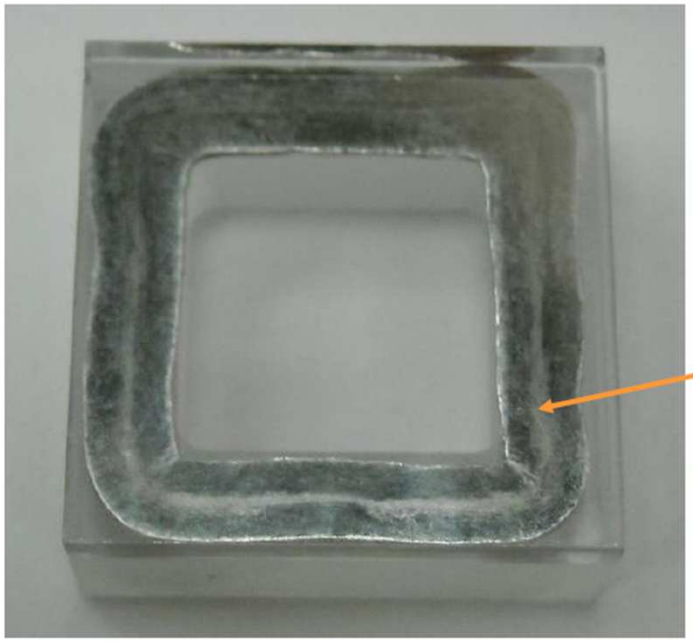
Preliminary Conclusions

- Samples with NiCr coatings had better leak test results than those with Ag layers.
- 66In/34Bi foil produced more discolored patches than 52In/48Sn at the silver paste layer-glass interface.
  - The composition and relevance of these patches are not yet determined
- Samples will be leak checked again in the future to determine effects of aging.

Compression Seal

Wire Seals

- Plastic deformation is key
- 100%In wire - 0.030” D



Area of indium oxide showing the original location of the wire.

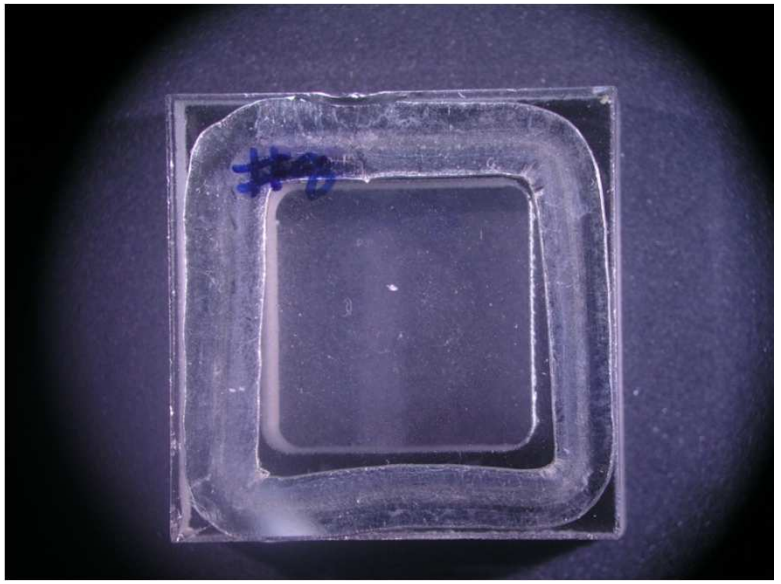
Compression Seal

3.B. Thermocompression tests (*)

Indium alloy	Temperature, °C	Force, lbs	Time, min	Comments	Leaking test,
Pure indium wire	~ 30	700	10	Good deformation	Background: < 1.0×10^{-10} Leak at wire overlap
		800		Good deformation	Background: < 1.0×10^{-10} Leak at wire overlap
		800		Good deformation	Background: < 1.0×10^{-10} Leak at wire overlap
	~ 40	800	10	Partial deformation	Background: < 1.0×10^{-10} No Leak
		800		Partial deformation	Did not pump down
		1000		Good deformation	Background: 5.0×10^{-10}

Recent Successes with a compression seal 1 inch Sample Parts

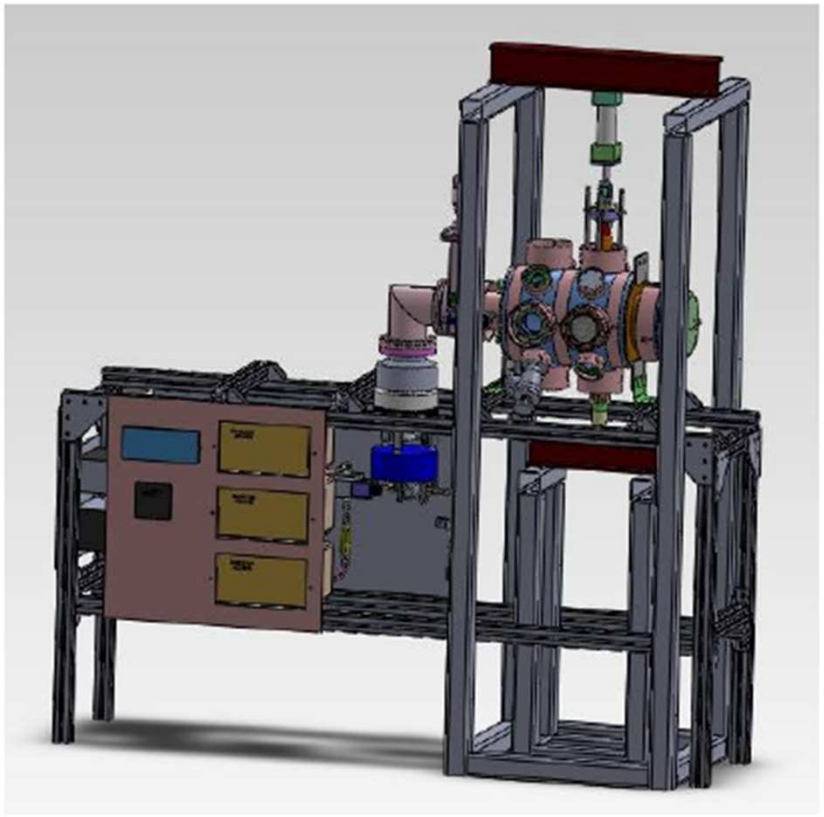
- With a loading of 800 lbs, seals have been made between both glass and NiCr coated glass substrates.
- The seal filler was pure indium in the form of .062” diameter wire
- These seals were made in air.
- All the parts were cleaned in acetone and alcohol.
- At loads of 600 lbs and lower the joint between the ends of the wire became a problem.
  - Although there is evidence that a seal was made at loads as low as 300 lbs .



800 lbs – 100 In – 20ºC – 1 minute

Equipment Progress

- Low Temperature Bonding System
  - Now operational for heating
    - Heating controls completed by HEP Electronics
    - Infrared lamps operational in the system.
  - Vacuum system
    - System leak tight
    - Base pressure of the system is 3 x 10^{-8} torr.
  - Hydraulics
    - Last parts being completed in shops
    - Hydraulic manifold leak tight and ready to move onto the system.



Future Plans

- Investigate the reduction and removal of the oxide layer on filler material and the substrate coatings.
- Continue to try tests of wire joints.
- Look at a other coating materials such as: chromium and aluminum
- Start to do the tests in the in vacuum rather than in air.

- Continue to pursue the soldering method
  - The system above has a heating capability to perform soldering in vacuum
- Fab samples that do not use flat surface to compress the seal, these samples will use beveled edges. It will be investigated that by applying the load in a small area improves the seal performance.