

Update on results at Coolescence, LLC

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Coolescence, LLC

- Founded in 2005, Angel funded, 3 researchers
- Areas of experiments
 - Calorimetry
 - Glow Discharge initiated LENR
Built on work of Karabut & Energetics
 - Gas flow initiated LENR
Modeled on work of Li



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Initial goal to measure excess heat with calorimeter -2 generations of calorimeter – will discuss 2nd generation.

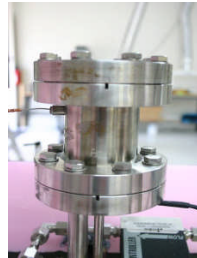
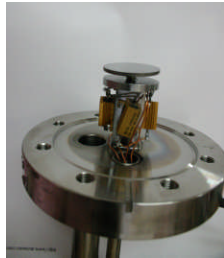
No positive excess heat results from GD work yet. Will discuss loading data

Gas discharge experiments started in July

Apparatus also suited to Li-like gas flow experiment. Initial results inconclusive – hence won't discuss detailed results – focus on setup

Calorimeter for GD Experiment

- Flow Calorimeter surrounding vacuum chamber (320 cm³)
- Cathode Pt RTD allows Isoperibolic operation
- Built-in Joule Heater



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Goal to build put a flow calorimeter around a small vacuum chamber – work over 10W with 1% error

During operation saw that isoperibolic operation also possible and more sensitive

- 1) Chamber open – note screw in cathode, heaters
- 2) Assembled chamber – note HV anode wire
- 3) Chamber with rear heat capture block

Calorimeter Engineering

- Dual In/Out temp measurement (thermistor)
- 2 stage fluid temp regulation (± 5 mDegC)
- Air temp regulation (± 50 mDegC)



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Fluid temp regulated with standard recirculating chiller + software controlled Peltier heater/cooler

Air temp regulated with software controlled Peltier heater/cooler

- 1) Chamber surrounded by both heat transfer pieces (Aluminum)
- 2) Heat transfer blocks surrounded by insulation
- 3) Entire assembly surrounded by constant temp box

Daul Calorimeter Block Diagram

Dual Calorimeter Fluid Flow & Temperature Control

The diagram illustrates the fluid flow and temperature control system for a dual calorimeter. It consists of two identical calorimeter blocks, each containing a Calorimeter Block and a Cold Plate. The Calorimeter Block is connected to the Cold Plate via a fluid path. The Cold Plate is connected to a Recirculating Chiller (external control) via a fluid path. The Recirculating Chiller is connected to the Cold Plate via a fluid path. The Calorimeter Block is connected to the Cold Plate via a fluid path. The Cold Plate is connected to the Recirculating Chiller via a fluid path. The Calorimeter Block is connected to the Cold Plate via a fluid path. The Cold Plate is connected to the Recirculating Chiller via a fluid path.

Legend:

- T** Calibrated thermistor-pair with precision bias – measure volts
- T** 2-wire RTD – measure temp, adjust offset
- Fluid Path
- Control Path

Signals per chamber

DVM Input:

- T1-6, T1-10, T1-14, T1-18, T1-22, T1-26, T1-30, T1-34, T1-38, T1-42, T1-46, T1-50, T1-54, T1-58, T1-62, T1-66, T1-70, T1-74, T1-78, T1-82, T1-86, T1-90, T1-94, T1-98, T1-102, T1-106, T1-110, T1-114, T1-118, T1-122, T1-126, T1-130, T1-134, T1-138, T1-142, T1-146, T1-150, T1-154, T1-158, T1-162, T1-166, T1-170, T1-174, T1-178, T1-182, T1-186, T1-190, T1-194, T1-198, T1-202, T1-206, T1-210, T1-214, T1-218, T1-222, T1-226, T1-230, T1-234, T1-238, T1-242, T1-246, T1-250, T1-254, T1-258, T1-262, T1-266, T1-270, T1-274, T1-278, T1-282, T1-286, T1-290, T1-294, T1-298, T1-302, T1-306, T1-310, T1-314, T1-318, T1-322, T1-326, T1-330, T1-334, T1-338, T1-342, T1-346, T1-350, T1-354, T1-358, T1-362, T1-366, T1-370, T1-374, T1-378, T1-382, T1-386, T1-390, T1-394, T1-398, T1-402, T1-406, T1-410, T1-414, T1-418, T1-422, T1-426, T1-430, T1-434, T1-438, T1-442, T1-446, T1-450, T1-454, T1-458, T1-462, T1-466, T1-470, T1-474, T1-478, T1-482, T1-486, T1-490, T1-494, T1-498, T1-502, T1-506, T1-510, T1-514, T1-518, T1-522, T1-526, T1-530, T1-534, T1-538, T1-542, T1-546, T1-550, T1-554, T1-558, T1-562, T1-566, T1-570, T1-574, T1-578, T1-582, T1-586, T1-590, T1-594, T1-598, T1-602, T1-606, T1-610, T1-614, T1-618, T1-622, T1-626, T1-630, T1-634, T1-638, T1-642, T1-646, T1-650, T1-654, T1-658, T1-662, T1-666, T1-670, T1-674, T1-678, T1-682, T1-686, T1-690, T1-694, T1-698, T1-702, T1-706, T1-710, T1-714, T1-718, T1-722, T1-726, T1-730, T1-734, T1-738, T1-742, T1-746, T1-750, T1-754, T1-758, T1-762, T1-766, T1-770, T1-774, T1-778, T1-782, T1-786, T1-790, T1-794, T1-798, T1-802, T1-806, T1-810, T1-814, T1-818, T1-822, T1-826, T1-830, T1-834, T1-838, T1-842, T1-846, T1-850, T1-854, T1-858, T1-862, T1-866, T1-870, T1-874, T1-878, T1-882, T1-886, T1-890, T1-894, T1-898, T1-902, T1-906, T1-910, T1-914, T1-918, T1-922, T1-926, T1-930, T1-934, T1-938, T1-942, T1-946, T1-950, T1-954, T1-958, T1-962, T1-966, T1-970, T1-974, T1-978, T1-982, T1-986, T1-990, T1-994, T1-998, T1-1002, T1-1006, T1-1010, T1-1014, T1-1018, T1-1022, T1-1026, T1-1030, T1-1034, T1-1038, T1-1042, T1-1046, T1-1050, T1-1054, T1-1058, T1-1062, T1-1066, T1-1070, T1-1074, T1-1078, T1-1082, T1-1086, T1-1090, T1-1094, T1-1098, T1-1102, T1-1106, T1-1110, T1-1114, T1-1118, T1-1122, T1-1126, T1-1130, T1-1134, T1-1138, T1-1142, T1-1146, T1-1150, T1-1154, T1-1158, T1-1162, T1-1166, T1-1170, T1-1174, T1-1178, T1-1182, T1-1186, T1-1190, T1-1194, T1-1198, T1-1202, T1-1206, T1-1210, T1-1214, T1-1218, T1-1222, T1-1226, T1-1230, T1-1234, T1-1238, T1-1242, T1-1246, T1-1250, T1-1254, T1-1258, T1-1262, T1-1266, T1-1270, T1-1274, T1-1278, T1-1282, T1-1286, T1-1290, T1-1294, T1-1298, T1-1302, T1-1306, T1-1310, T1-1314, T1-1318, T1-1322, T1-1326, T1-1330, T1-1334, T1-1338, T1-1342, T1-1346, T1-1350, T1-1354, T1-1358, T1-1362, T1-1366, T1-1370, T1-1374, T1-1378, T1-1382, T1-1386, T1-1390, T1-1394, T1-1398, T1-1402, T1-1406, T1-1410, T1-1414, T1-1418, T1-1422, T1-1426, T1-1430, T1-1434, T1-1438, T1-1442, T1-1446, T1-1450, T1-1454, T1-1458, T1-1462, T1-1466, T1-1470, T1-1474, T1-1478, T1-1482, T1-1486, T1-1490, T1-1494, T1-1498, T1-1502, T1-1506, T1-1510, T1-1514, T1-1518, T1-1522, T1-1526, T1-1530, T1-1534, T1-1538, T1-1542, T1-1546, T1-1550, T1-1554, T1-1558, T1-1562, T1-1566, T1-1570, T1-1574, T1-1578, T1-1582, T1-1586, T1-1590, T1-1594, T1-1598, T1-1602, T1-1606, T1-1610, T1-1614, T1-1618, T1-1622, T1-1626, T1-1630, T1-1634, T1-1638, T1-1642, T1-1646, T1-1650, T1-1654, T1-1658, T1-1662, T1-1666, T1-1670, T1-1674, T1-1678, T1-1682, T1-1686, T1-1690, T1-1694, T1-1698, T1-1702, T1-1706, T1-1710, T1-1714, T1-1718, T1-1722,

- 1) constant volume pump
- 2) 2nd stage input temp polish
- 3) cool fluid back to original temp for 2nd chamber
- 4) controlled by LabView program
- 5) Agilent 34970 6-1/2 digit data acquisition

Calorimeter Performance

- Flow Calorimeter
 - Sensitivity: 20mW
 - Capture Ratio: 90-94%
 - Time constant: 19 minutes
- Isoperibolic Calorimeter
 - Sensitivity: 5mW
 - Time constant: 5 minutes
 - Sensitive to pressure, heat location

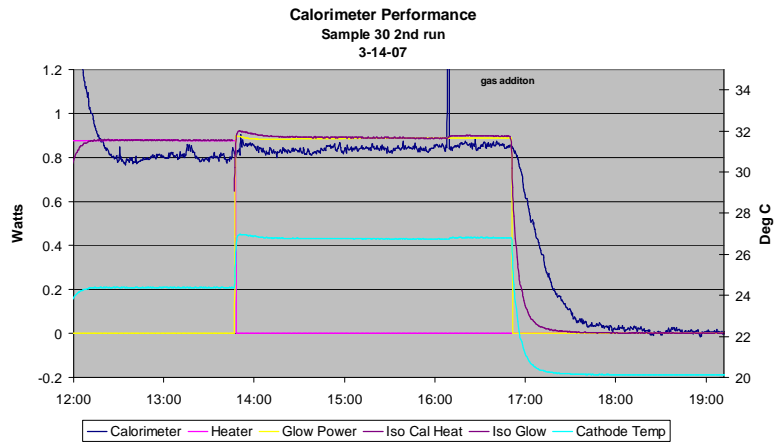


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Flow calorimeter has ~2% variation based on location/type of heat, slow
Isoperibolic – more sensitive – very large variations based on heat location,
pressure, gas type

We've been fooled by small changes in amount of D2 – D2 is very conductive.

Typical Performance



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Isoperibolic used different calibration constants for glow or heater
No calibration constant used for flow calorimeter (just zeroed)

Glow Discharge Loading of Pd

- Initial focus on Glow Discharge initiated LENR using calorimetry to find anomalous heat
- No excess heat results
- Characterize deuterium loading with Glow Discharge



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Apparatus & Techniques

- .3 & 1.5 liter chambers
- Glow in 1-10 torr D₂
- Pd foils (25-100 micron) attached with diffusion weld
- Pd & Pd alloy thin films (1-5 micron) on copper
- Loading measured by gas loss (pressure drop)
- Verify by pressure rise during unloading
- Capacitive Manometers



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Use standard cathode 1.2" Cu disk

Screws into holder – can cool with water

Test foils welded – also tried screws, adhesive-

Baratron gauges – fast, gas insensitive

Example of sputtered disks – provided by Colorado School of Mines under a research contract we established with them

Major Loading Observations

- No high loading ($D/Pd < .7$)
- No bulk loading at higher temperatures
- Loading rate proportional to current ($J < 100 \text{ mA/cm}^2$)
- 5-10 D's loaded for each D+ of ion current (Faradaic Efficiency 5-10)
- High D flux during pulsed discharge ($.01 \text{ sccm/cm}^2$ per mA of glow)
- Loading rate insensitive to temperature, voltage, and pressure
- GD causes damage to Pd (sputtering)



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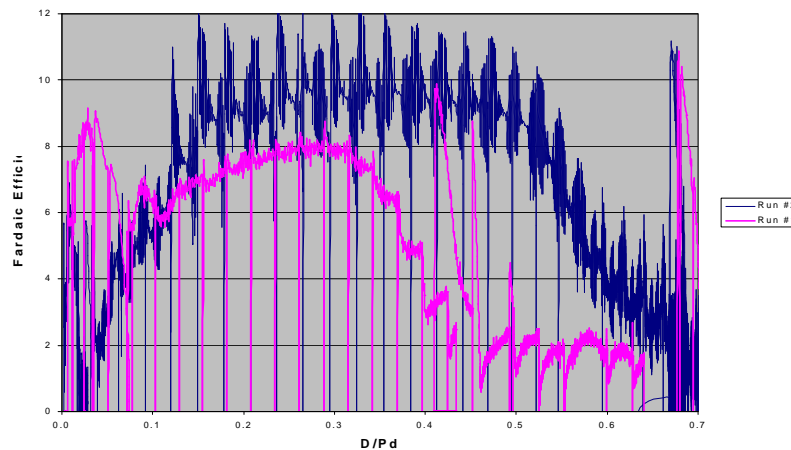
No loading above D/Pd 0.7

Temps's $> \sim 80$ deg C part Pd will unload at 5-10 torr – but will still load on surface

Loading rate appears insensitive to temperature, voltage, & pressure (most work on temperature)

High D flux - @100 mA glow flow is about 1 sccm – same order of magnitude as Iwamura work

Loading Efficiency vs. D/Pd



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Faradaic Efficiency: defined as number of D's removed from chamber for each electron of current flow

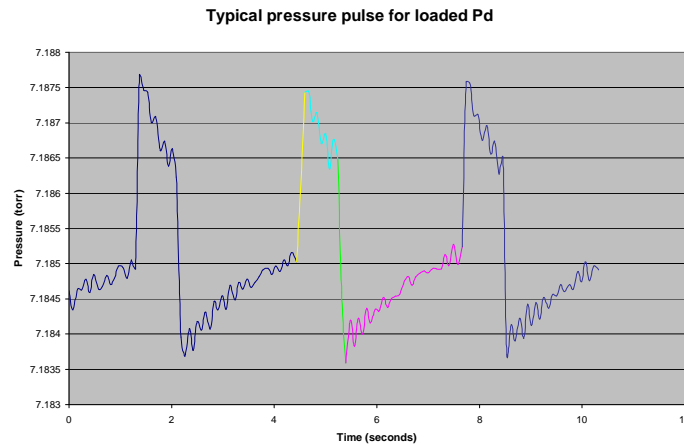
Characteristics:

Starts loading typically starts slower, flat area, then falls off.

down spikes where gas added.

Note: pink curve – stopped loading when glow off, unload when glow off, re-start with higher FE, then quickly falls off.

Pulsed Glow Discharge



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Pulse GD technique – appears useful in understanding loading behavior

Pulse GD – typical waveform with 4 regions

yellow – pulse on – pressure rise from heating

light blue – loading – pressure drop – slope is proportional to loading rate

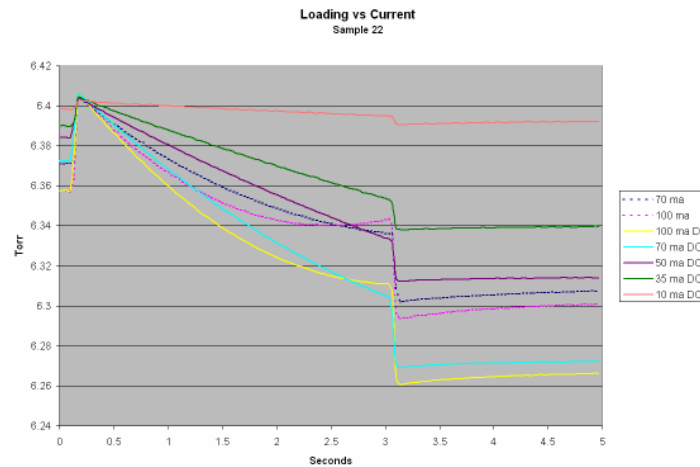
green – pulse off – pressure drop from cooling

pink – off period – unloading – slope is proportional to unloading rate –
unloaded part this is flat

When bulk is loading get overall downward slope – flat in the off region

When bulk is unloading get overall upward slope – unloads more in off period
than is loaded in on period

Loading vs. Glow Current



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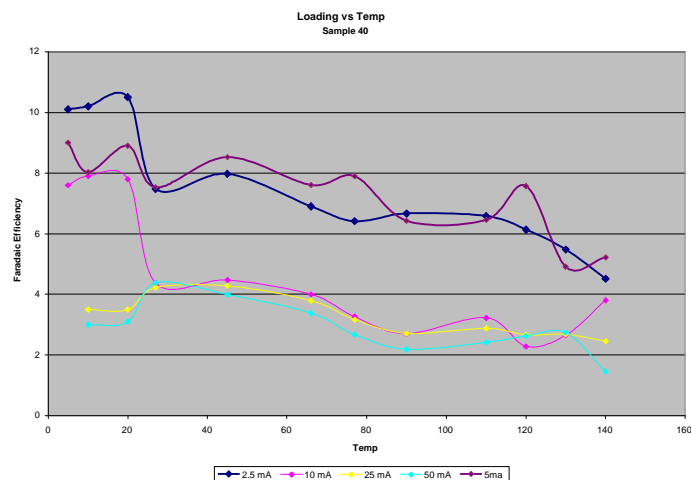
Example of pulsed loading data

Use slope to measure loading rate –

Loading rate is proportional to glow current

Note dotted pink turn around in the pressure – part is starting to unload during the glow

Loading Rate & Temperature



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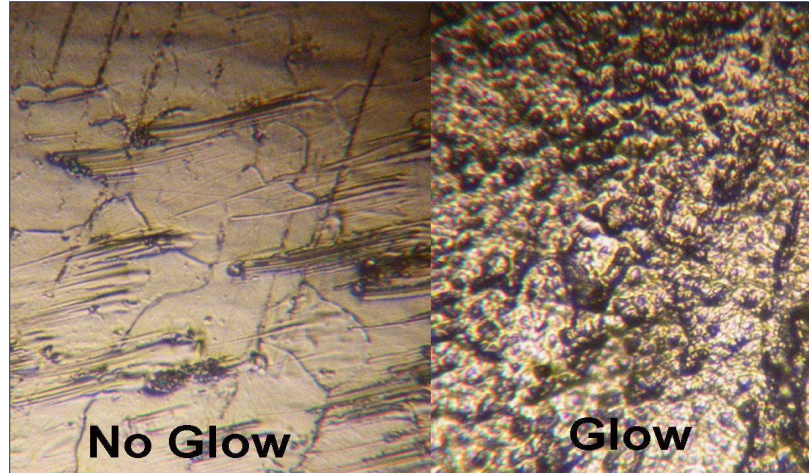


Not much sensitivity to temperature in loading rate with short pulses.

Note: we don't see bulk loading at higher temperatures – so this is a surface phenomena

Difference between higher and lower current is probably related to some glow escaping the region around the Pd cathode

Physical Effects of GD



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400x optical magnification

Significant sputtering of the Pd cathode is observed

Any special treatment on surface is rapidly sputtered away

Questions raised by GD loading results

- What is mechanism of loading?
- What limits loading to $D/Pd \sim 0.7$?
- Are common mechanisms at work in GD (Karabut, Savvitamova, Energetics, ...), gas flow (Li) and gas flow transmutation (Iwamura)?
- Was high loading present in earlier GD and gas flow experiments?



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Last question – is motivating our work

- 1) Loading is not wholly due to ions.
- 2) Do incoming ions that cause sputtering also “shake” D out of the lattice?
- 3) This works suggests that high bulk loading is probably not involved in Karabut, Li, Iwamura experiments.

Gas Flow Experiment

- Flow D2 through Pd foil
- High pressure side ~ 1000 torr D2, volume 15 cc
- Low pressure side $< 10^{-3}$ torr, volume 320 cc
- Ramp foil temperature with resistive heater 120-170-120 deg C
- Chamber enclosed in constant temp environment (calorimeter)
- Look for anomalies by subtracting heating ramp from cooling ramp

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Attempt to replicate Prof Li's gas flow work (Li first reported at ICCF-9)

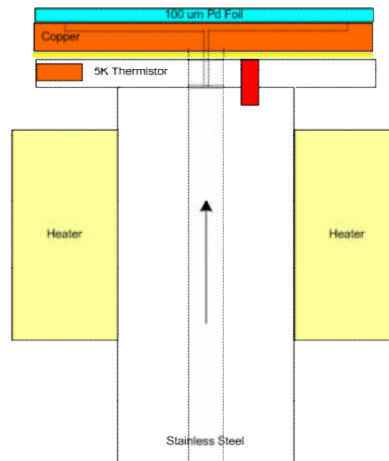
General Idea: Flow gas through a Pd foil – change temp of foil.

Monitor temps, flows, gas composition (with RGA)

This is tricky calorimetry – input power > 10 W required to heat foil. Li saw excess heat in the few mW range

Sample Preparation

- 100 micron Pd foil diffusion welded to copper holder
- Pd/Cu assembly screwed into stainless steel holder
- Sealed with 75 um Teflon gasket

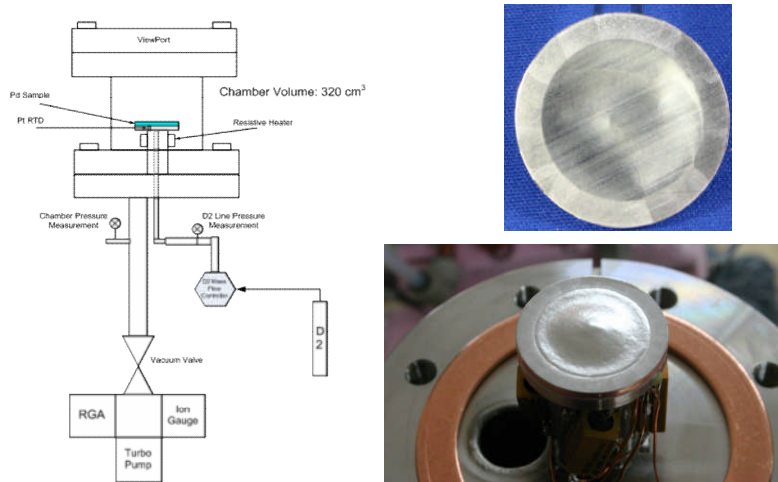


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Build sealed assembly

- welded foil,
- gasket, vacuum grease between SS and Cu part
- note direction of gas flow - $D_2 > 1$ atmosphere

Gas Flow Apparatus



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Gas flows through a 0.9" diameter (4.1 cm²) opening. Changes in foil temp coupled through Cu to Pt RTD sensor (thermistor added recently)

D2 pressure controlled with mechanical regulator (not very accurate or stable)

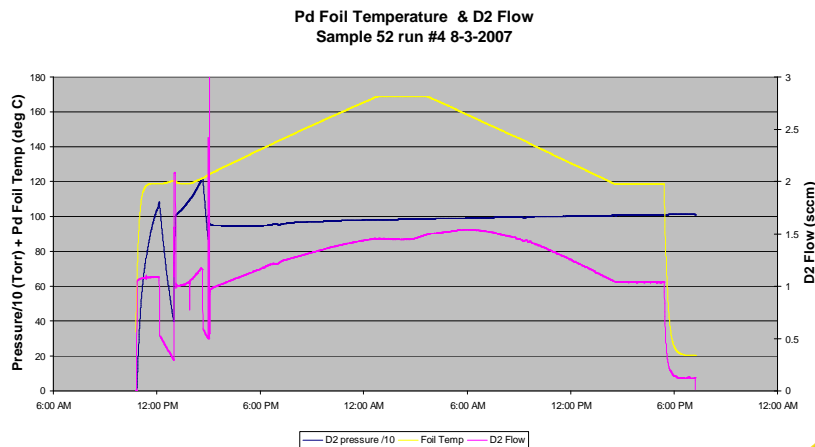
Upper: Picture of sample after welding but before flow

Lower: Picture of sample after flow experiment.

Note: Mass flow controller used to limit gas flow (safety) and used as a mass flow meter.

Ion Gauge and RGA partial pressures also a good indicator of flow

Typical Gas Flow Run



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Typical run – temp ramp, hold at top for 3 hours, ramp down

Tried various temp ramps 15 deg /hour to 5 deg/hour

Flow increases with increasing temp as expected.

Subtract Heating – Cooling and Look at derivatives of flow and temp for anomalies

So far no conclusive results – observed anomalies may be due to temp probe issues or variations in vacuum-side D2 pressure

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