Update on results at Coolescence, LLC

Rick Cantwell
Coolescence, LLC
Boulder, CO
rick@coolescence.com
+1 720-565-9690

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 cm^3)
- 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

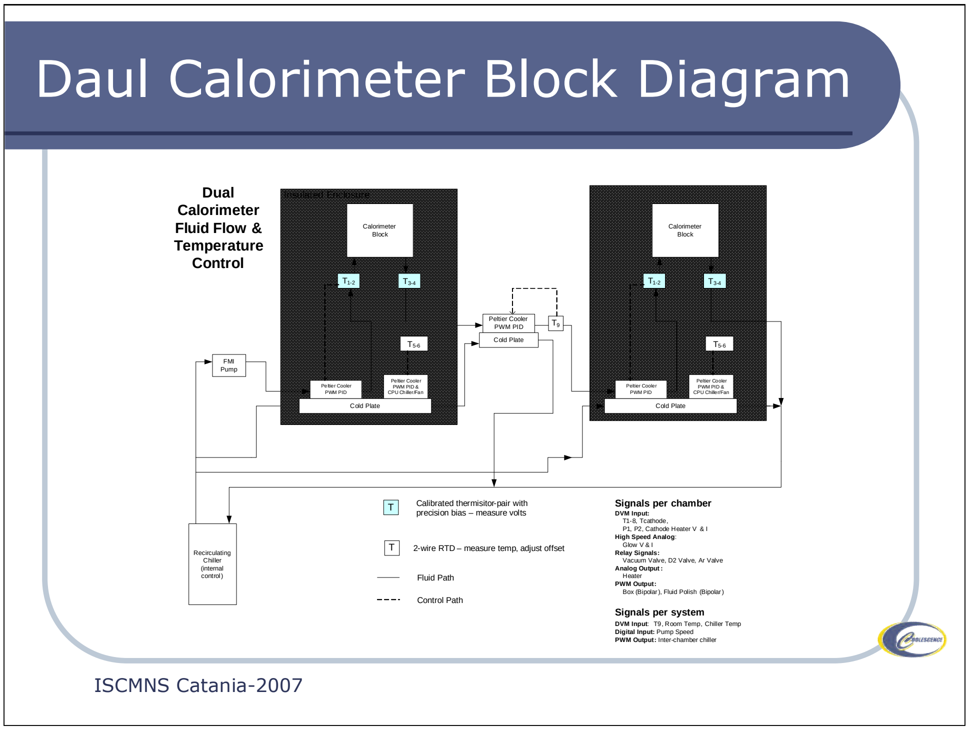
Calorimeter Engineering

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

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



Built as two similar units side by side – allows for direct comparison of control parts

1) constant volume pump
2) 2^{nd} stage input temp polish
3) cool fluid back to original temp for 2^{nd} 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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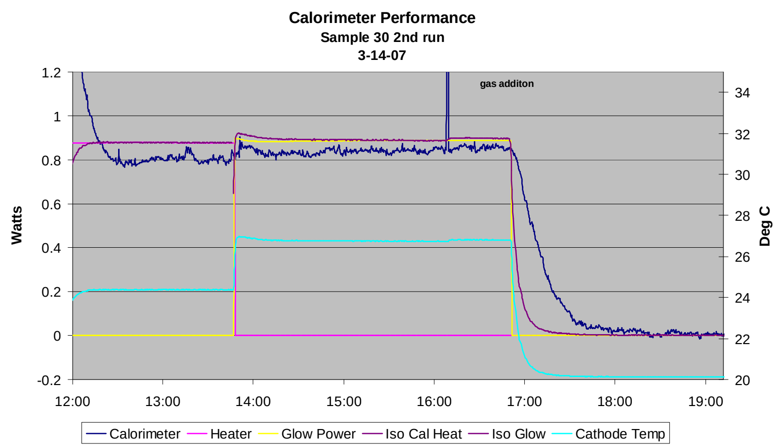
Flow calorimeter has ~2% variation based on location/type of heat, slow

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

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<100mA/cm2)
- 5-10 D's loaded for each D+ of ion current (Faradaic Efficiency 5-10)
- High D flux during pulsed discharge (.01 sccm/cm2 per mA of glow)
- Loading rate insensitive to temperature, voltage, and pressure
- GD causes damage to Pd (sputtering)

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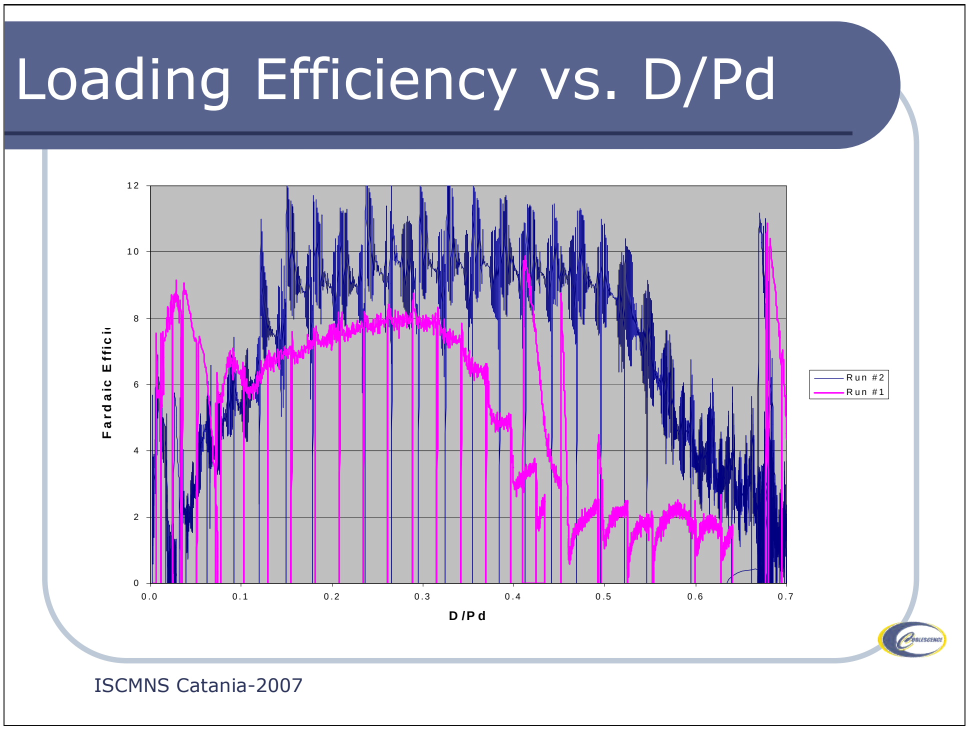
No loading above D/Pd 0.7

Temps's > ~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



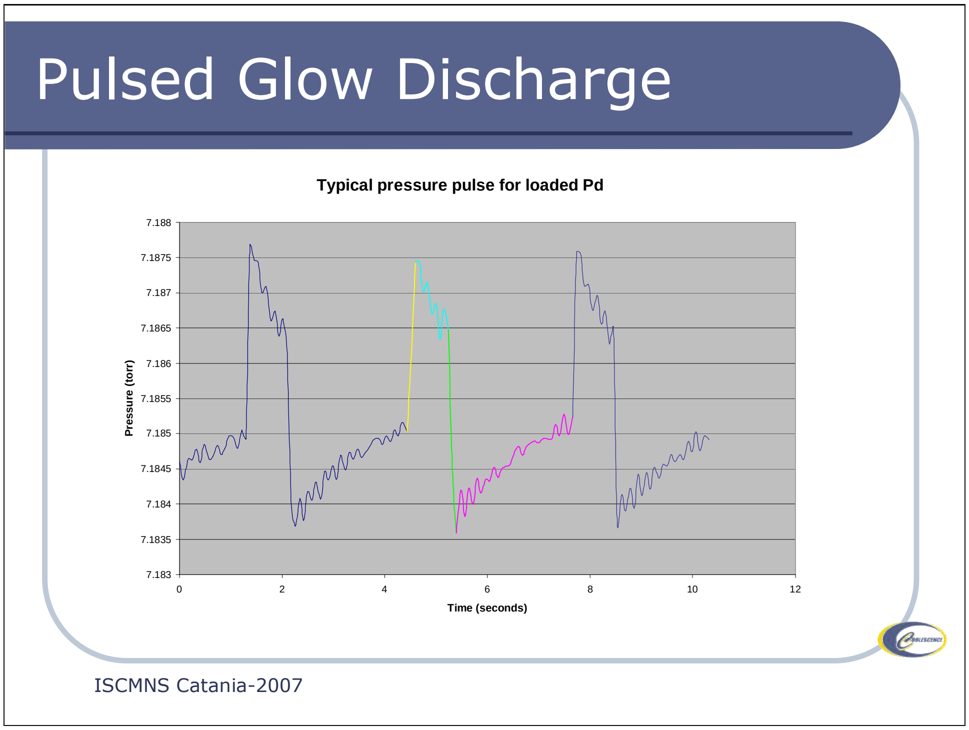
Faradaic Efficiency: defined as number of D's removed from chamber for each electron of current flow

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.



Pulse GD technique – appears useful in understanding loading behavior

Pulse GD – typical waveform with 4 regions

yellow – pulse on – pressure rise from heating

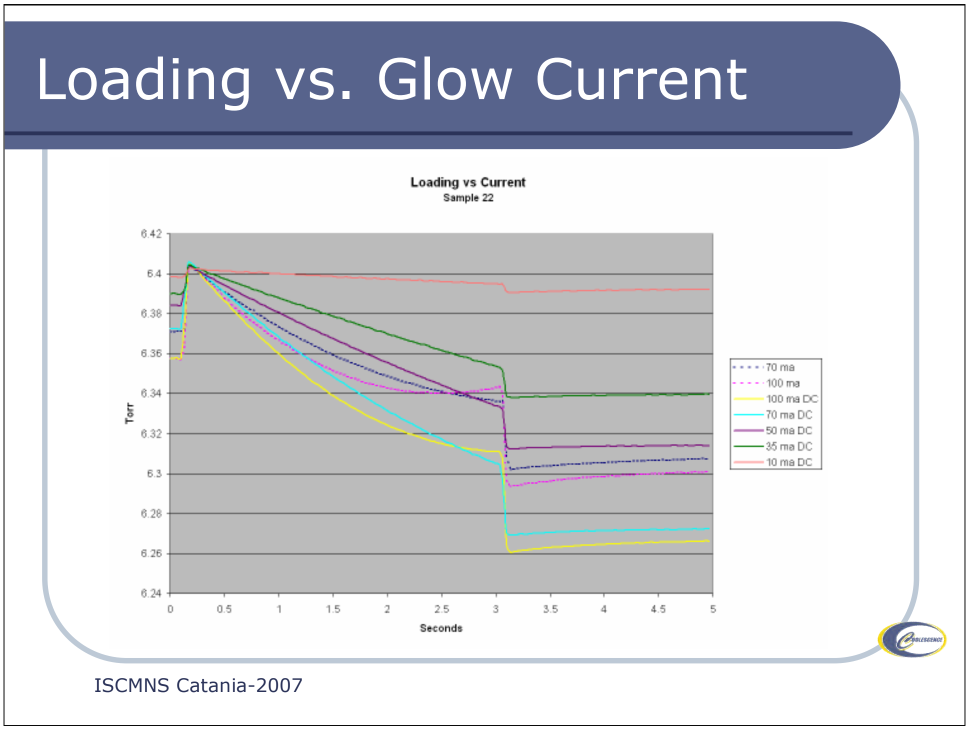
light blue – loading – pressure drop – slope is proportional to loading rate

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



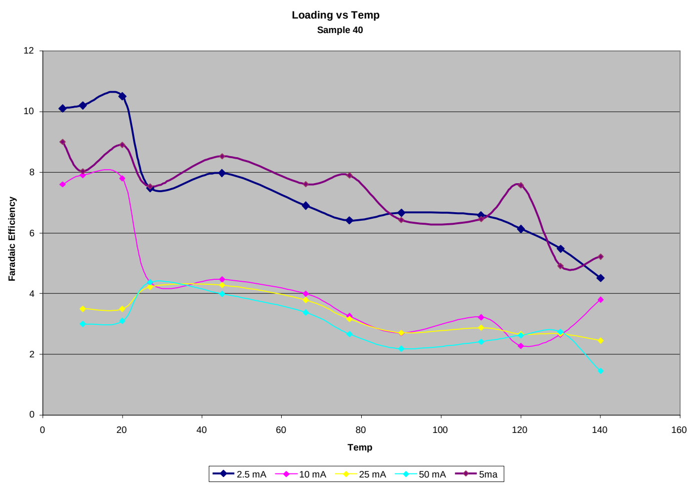
Example of pulsed loading data

Use slope to measure loading rate –

Loading rate is proportional to glow current

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

Loading Rate & Temperature



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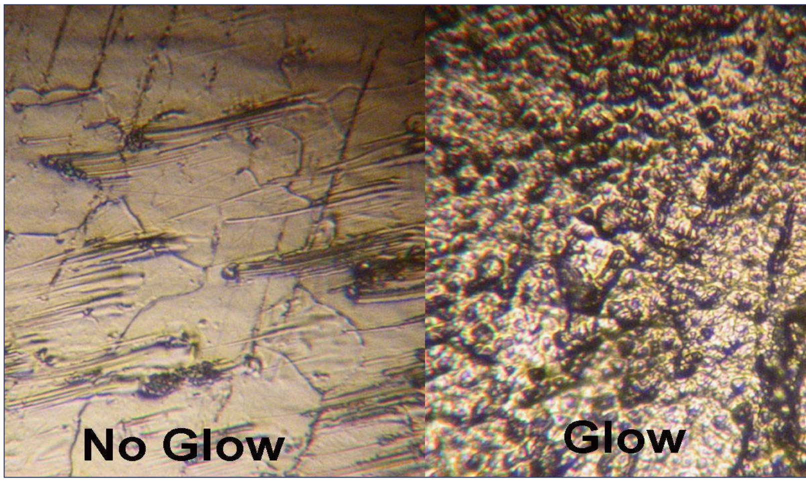
Not much sensitivity to temperature in loading rate with short pulses.

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 ~ 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 <1e-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)

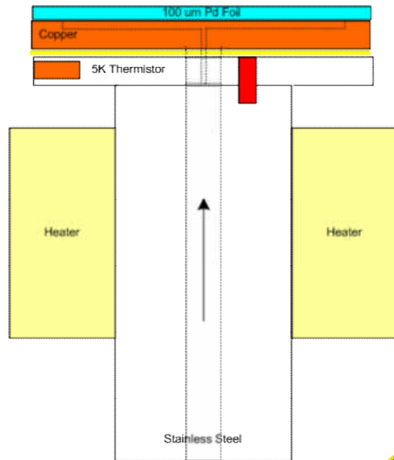
General Idea: Flow gas through a Pd foil – change temp of foil.

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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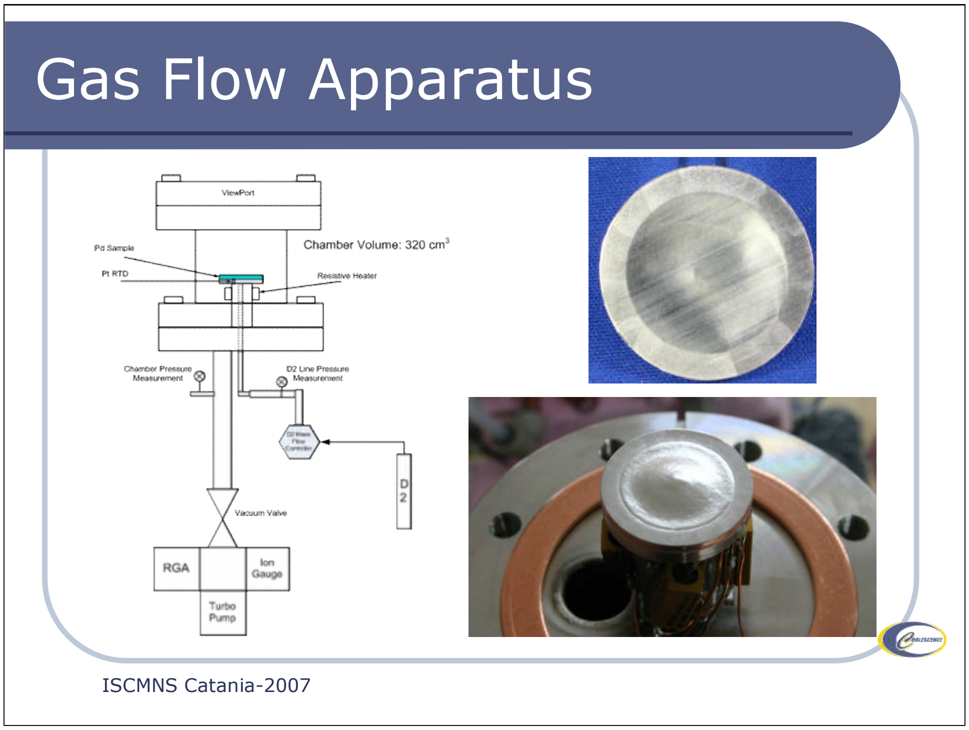
Build sealed assembly

- welded foil,

-gasket, vacuum grease between SS and Cu part

-note direction of gas flow - D2 > 1 atmosphere



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)

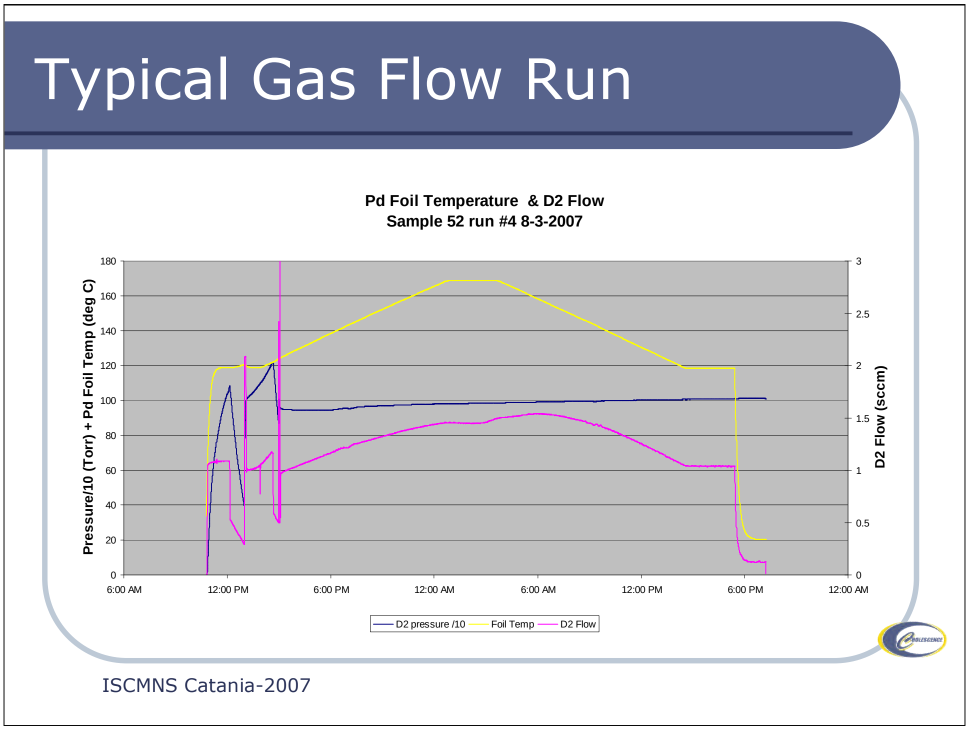
D2 pressure controlled with mechanical regulator (not very accurate or stable)

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 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 derivates 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

Acknowledgements

- Scott Little
- Ed Storms
- Xing Zhong Li