ALD update

J. Norem
ANL/HEP

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Argonne
NATIONAL LABORATORY

Argonne MAP effort

Argonne MAP related effort (~0.6 FTE) :

- Understanding Arcs and Gradient limits
  - Design of ALD cavity experiment
    - Cavity
    - Coating system
    - Instrumentation
    - R&D Plan
    - Optimization of coatings
    - Safety
- Support MuCool RF

Non MAP related

- Superconducting ALD coatings
- Coating cavities
- Plasma ALD

So far this FY.

New exp. data on extreme arc types:

- Quantitative measurements from 805 optical diagnostics
- Analysis of 201 coupler arc tracks
  - SEM pictures

Analysis of plasma driven arcs

- Arcing without an applied E field is interesting and relevant in many fields.

Continuation of self-sputtering studies

- Dependence on Temp and E field done,
- Grain orientation calculations just finished
  - Experiments underway

Tests with ALD for SRF

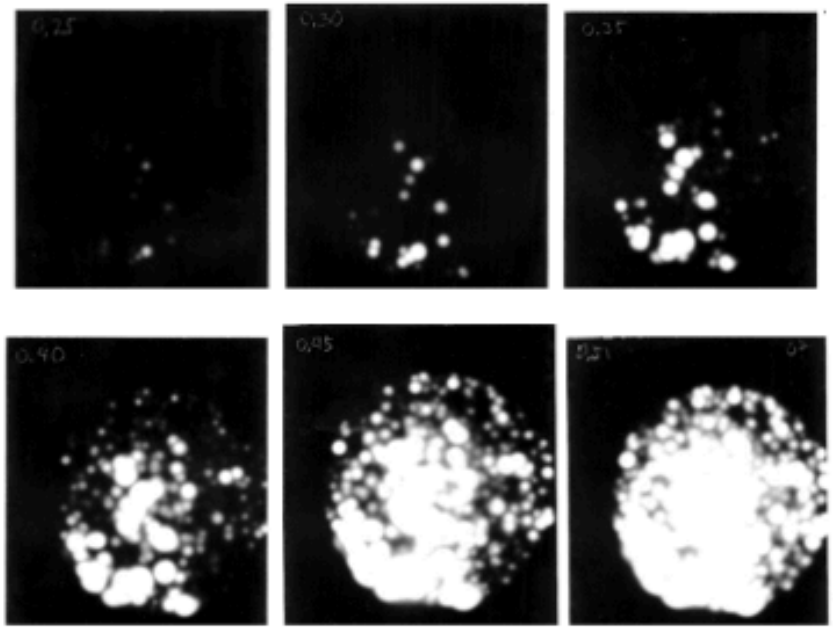
- Coating optimization
- Cavity coating expt.
- Bringing up the plasma enhanced ALD system

ALD coating idea

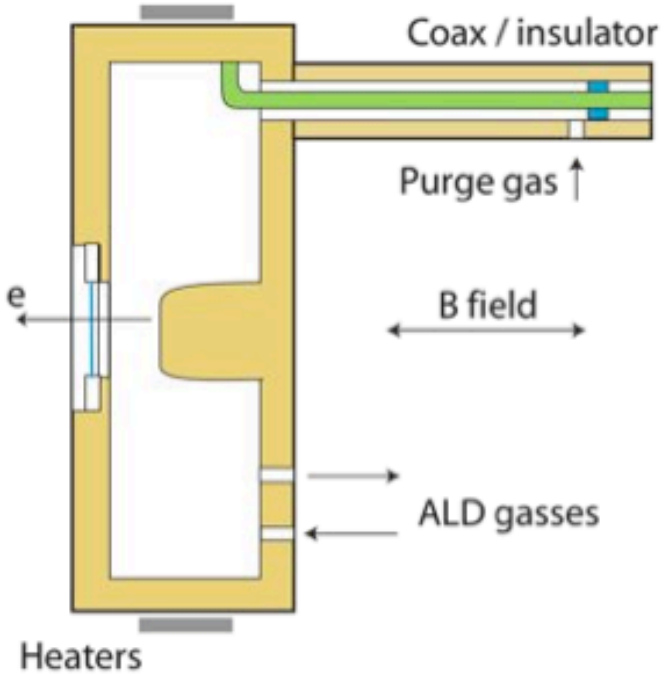
- Atomic Layer Deposition can conformally coat emitters & breakdown sites during operation, increasing local radii, reducing the local field, $E_l \sim 1/r$, field emission, $\sim E_l^{14}$, and breakdown rate $\sim E_l^{30}$. As little as a few nm might do it.

- The experiment will be done in the Fermilab MTA.

- We can monitor field emission patterns with Polaroid film or other instrumentation as shown in old data (increasing field) for a similar geometry.



The cavity



Goals of the experiment

Increased gradients.

Better understanding of breakdown sites.

Better understanding of the required technology for preventing BD.

Cavity Design

The basic cavity requirements are fairly simple.

- 805 MHz
- Localized source of field emission and breakdown events
- Flat windows

The constraints of ALD are primarily concerned with the power window.

- This seems to negate the use of waveguide coupling

Coax coupling should work.

- We are planning a test of tolerable power through an ALD coated window.

Cavity design is underway, tricky parts:

- Power coupling
- Electrical pickups
- Optical windows
- Beam windows
- ALD connections

Coating Optimization

ALD groups are not usually concerned with the mechanical properties of coatings

Mechanical properties may be relevant to rf applications.

We have been developing techniques for measuring & optimizing:

- Tensile strength
- Resistivity
- Stability
- Safety

Measurement and optimization of relevant parameters is underway

Preliminary schedule

design/build cavity (12 weeks)
safety review (3 weeks)
process optimization (10 weeks)
Design of coating system (2 man months)
Construction of coating system (4 man months)
Safety approvel of system (3 months)
pre-coating run (2 weeks)
setup and coating (1 week)
rerun (2 weeks)

Safety

Preliminary discussions with FNAL safety primarily centered on gas requirements.

Preliminary discussions with ANL safety wanted a complete picture of expt,
Mechanical, chemical and procedural.

All these issues depend on the specific coating that must be applied.
The optimum coating has not been identified.

The Argonne Work Planning and Control (WPC) procedure requires various modules and tasks to be submitted before approval is issued.

We are sorting out how this can be done.

Two Problems:

1) We disagree with existing arc modeling explanations.
   This is very general, basic work with wide applicability
   We are visible participants and can't drop the effort.

2) Our ALD request was for design and analysis effort, + equipment funds.
   We have equipment funds but not for design and analysis.
   I'm getting flak for slow progress on un-funded work

Conclusions

Breakdown-proof rf cavities are a great idea will be a great experiment.!

Needs design and optimization effort.