Rebecca Seviour

*UK MICE Cavity (proposed) program*

Cockcroft Institute

(Dept. Engineering, Lancaster University, UK)

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Cockcroft Institute,
Accelerator Science and Technology Institute.

Over 90 research staff from;
Lancaster Uni (Engineering, Physics)
Liverpool Uni (Physics)
Manchester Uni (Physics)
ASTeC (Daresbury + RAL)
Motivation for RF cavity program

- Current accelerating gradients lower than maximums
- Poor reproducibility
- Current EP based techniques a *black art.*
- UK capacity building
- Complement USA program
Motivation

We propose to conduct a systematic review of each stage of manufacture. Investigating the effect each stage has on the surface topology and chemical composition of the surfaces, and ultimately the effect on cavity performance.
**Surface Chemistry: Auger spectroscopy**

Auger spectroscopy probes the chemistry of a surface by measuring the energy of electrons emitted from that surface when it is irradiated with electron of energy in the range 2–50 keV.

The incident electrons can remove a electron from a core state. This core state can be filled by an outer shell electron from the same atom, in which case the electron moves to a lower energy state.

Excess energy is released by ejecting a second outer shell electron from the atom.
**Surface Topology: Atomic Force Microscopy**

Operate by measuring attractive or repulsive forces between a tip and sample.

- Contact mode, tip at the end of a cantilever touches the sample (force on sample $<10^{-9}$ N). Raster-scan drags the tip over the sample, measuring the vertical deflection of the cantilever, which indicates the local sample height. Thus, in contact mode the AFM measures hard-sphere repulsion forces between the tip and sample.

- Noncontact mode, the AFM derives topographic images from measurements of attractive forces.

- AFMs can achieve a resolution of 10 pm.
In situ measurements: AFM & Auger spectroscopy

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~50 cm
Cavity Forming

- Cavity Spinning
  - Auger on plate sample
  - AFM before/after spinning
- Weld
- Mechanical checks
  - leak test
  - weld inspect
  - eccentricity
  - frequency tuning
  - Auger & AFM
Surface Preparation

- Mechanical polish (graded sandpaper)
- Ultrasonic cleaning
- Deoxidation/etch,

After each Step Auger & AFM

- DI water high-pressure rinse

EP  BCP  CMP

Will use simple pill box cavity to evaluate different cleaning regimes. Use best identified to treat Cavity.

Dependent upon resource will look to test at MTA / Daresbury
CMP cheaper & less hazardous than EP.

Only useful on flat areas

(Rohm and Haas Electronic Materials)
Examine surface conductance numerically

**Ni**

**NiO**

Use DFT codes to determine band structure/DOS

Use transport codes developed by C. Lambert (Lancaster) to determine conductance of surfaces. Use this to compare to experimental data.
Conclusion

• Use in situ Auger & AFM to determine how each step in the cavity manufacture effects surface topology and chemistry.

• Using test pill box for a variety of cleaning regimes.

• Use numerical study to determine how surface structure/chemistry effects transport and hence cavity performance, Compare with experimental results.

• Evaluating each for reproducibility & performance

• Complement US RF Cavity research programme

• Produce a cavity for MICE

• Infrastructure development will enable UK to participate more in accelerator research programmes