GENERAL ATOMICS
AND AFFILIATED COMPANIES

IFE foam characterization

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High Z coatings for IFE applications

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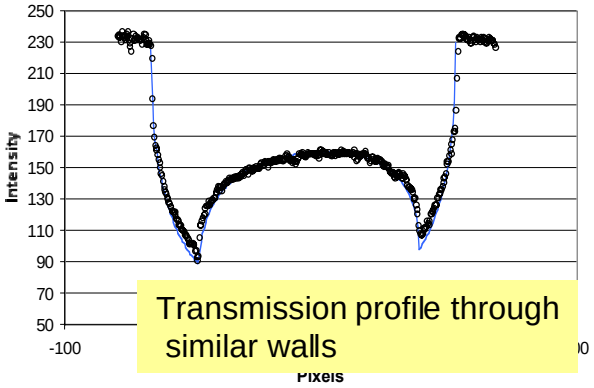
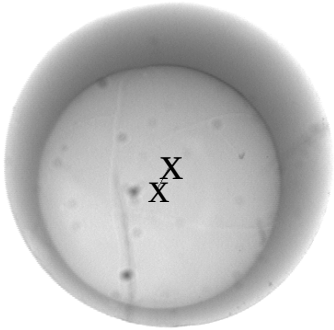
Report on foam characterization

Shadowgraphy may be used to measure diameter, OOR and NC

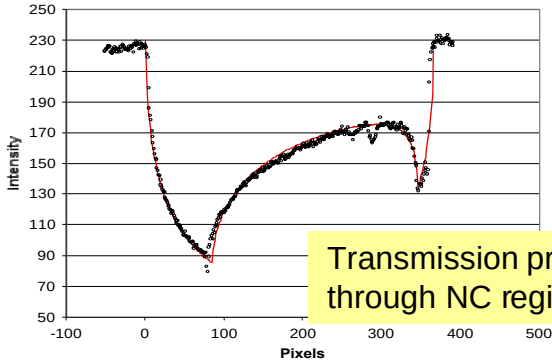


Transmission profile through similar walls



TMPT foam shell
In isopropanol

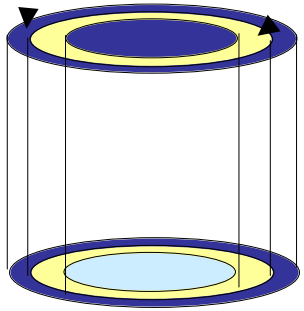
OD ≈ 800 μm

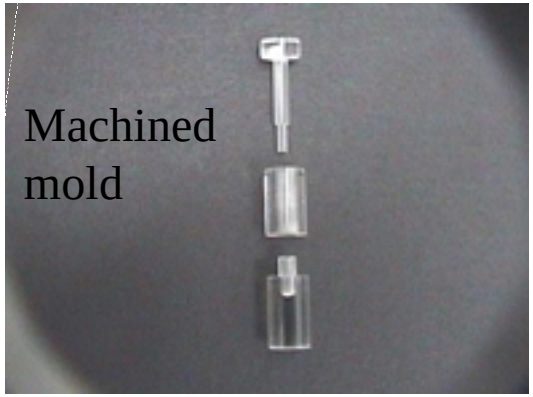


Transmission profile through NC region

Acrylic rod

Foam annulus



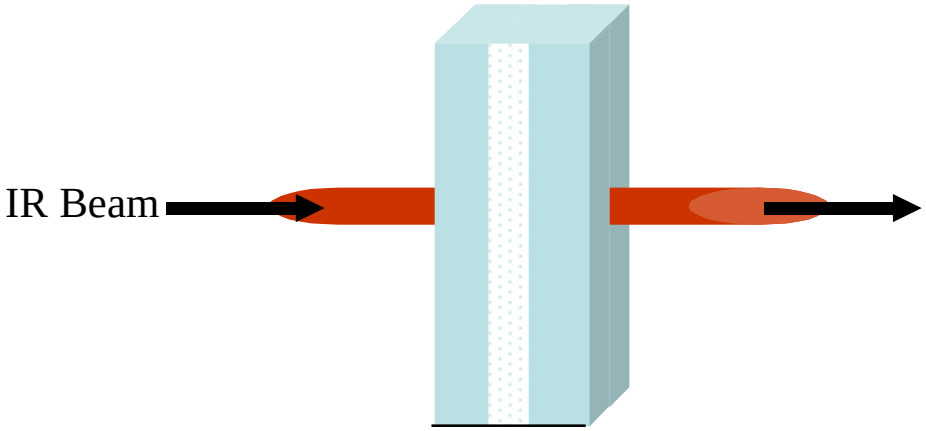


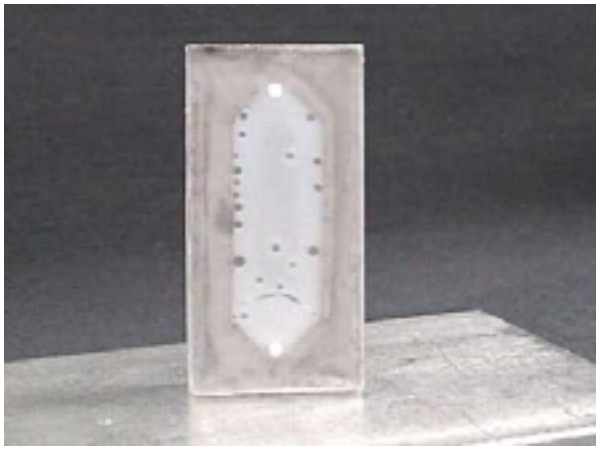
Idea: use foam annulus of accurately know dimensions as surrogate for shells

Acrylic mold dissolved in foam casting solvent at polymerization temperatures!

Areal density uniformity may be measured by IR absorption

IR absorption by DVB lines provides areal density uniformity information





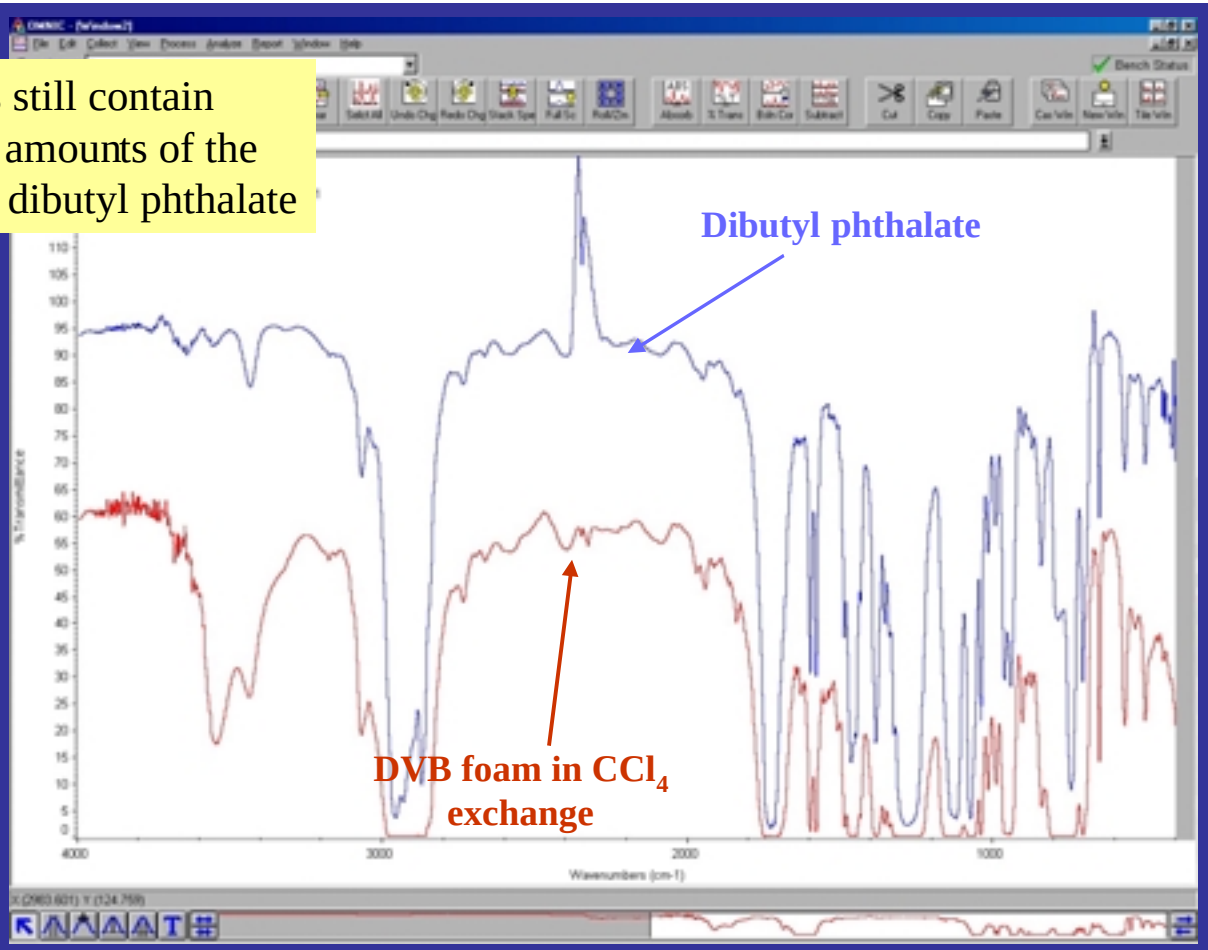
Foam is placed in index matched fluid to eliminate scattering
Index matching fluid is non-organic to avoid cluttered IR spectrum

Logo viewed through ~1mm of DVB foam

Foam Wedge in CS_2

Solvent exchange is in process to clean up IR spectrum

Samples still contain significant amounts of the foam solvent dibutyl phthalate



… will continue solvent exchange- determine viability of method

High Z coatings

Project objectives and summary

- Deposit high Z coatings : Au → **Pd** → **Au-Pd** – sputter coated
  - Deposition conditions

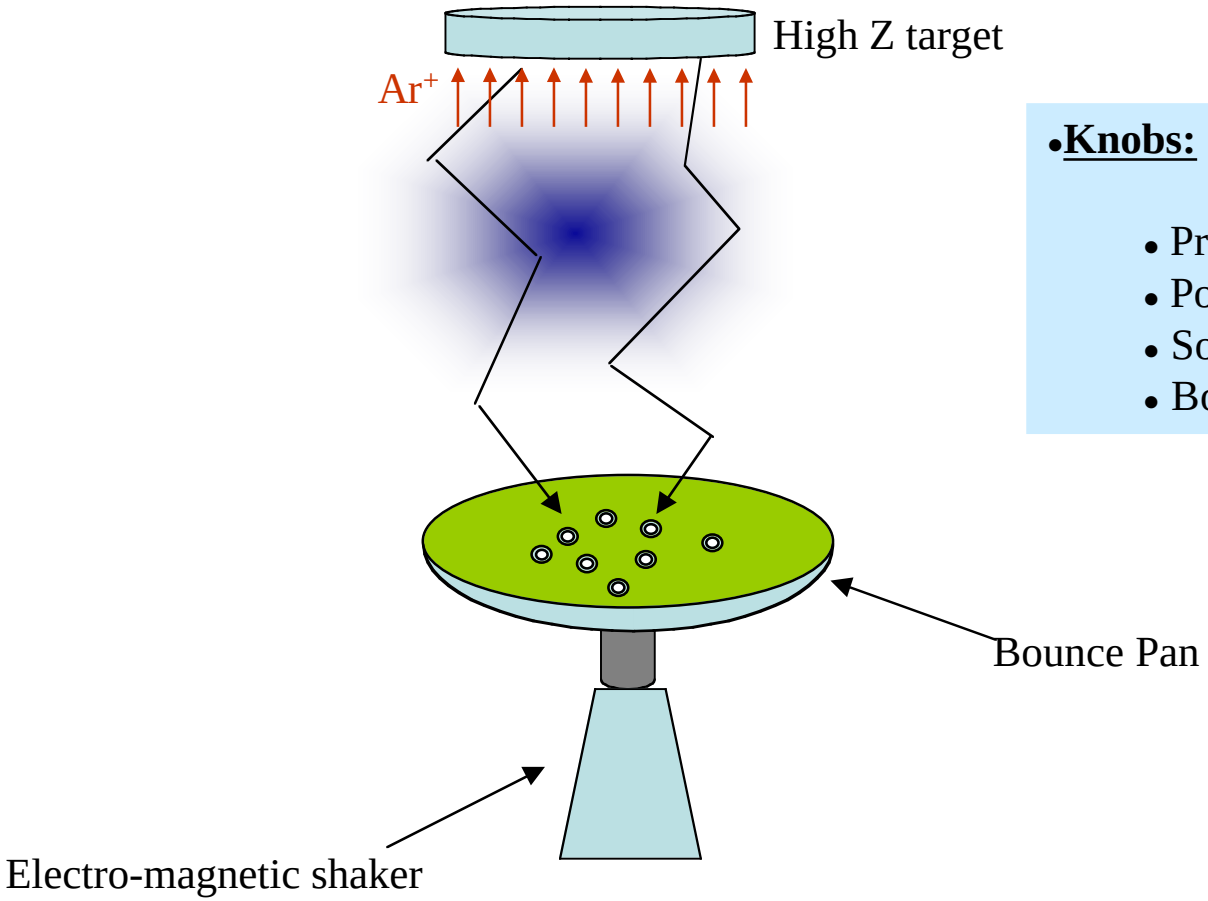
Reported on at last meeting-reviewed here

- Coat foam shells :
  - full density polymer shells, poly-alpha-methylstyrene (PAMS), as surrogates
- Target survival calculations :
  - Measure reflectivity of deposited films
  - Expect : Au better than Pd
- Fill time-Tritium inventory
  - Measure permeability of deposited films
  - Expect: Pd better then Au
- Does rapid filling with Pd outweigh the loss in reflectivity?
- What are the properties of Au-Pd mixtures?

A number of different measurements need to be performed on coatings

- **Coating thickness measurements:**
  - Coating uniformity on the shell
  - Shell-to-shell variations within a batch
  - Batch-to-batch variations
  - Used X-ray fluorescence measurements
- **Reflectance measurements of deposited films**
  - Ellipsometry:
    - determines n,k: optical constants- can calculate reflectivity, $R(\lambda,\theta)$
    - need to send out-takes time!- VIS+NIR+IR
  - Direct measurements:
    - In house at GA: Vis+IR-used as check on ellipsometry data
    - In our lab at GA: IR only- used for scoping studies
- **Permeability measurements on shells**
- **Tests for anticipated problems with Pd exposure to D_2**

High Z coating are deposited by physical vapor deposition: sputtering



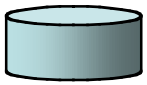
- **Knobs:**
  - Pressure
  - Power
  - Source-to-substrate distance
  - Bouncing

Shells bounce vigorously during coating process

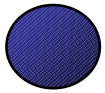
Proper bouncing leads to very uniform coatings

Coating thickness is normally measured by using a witness plate

Geometrically



$A=\pi R^2$

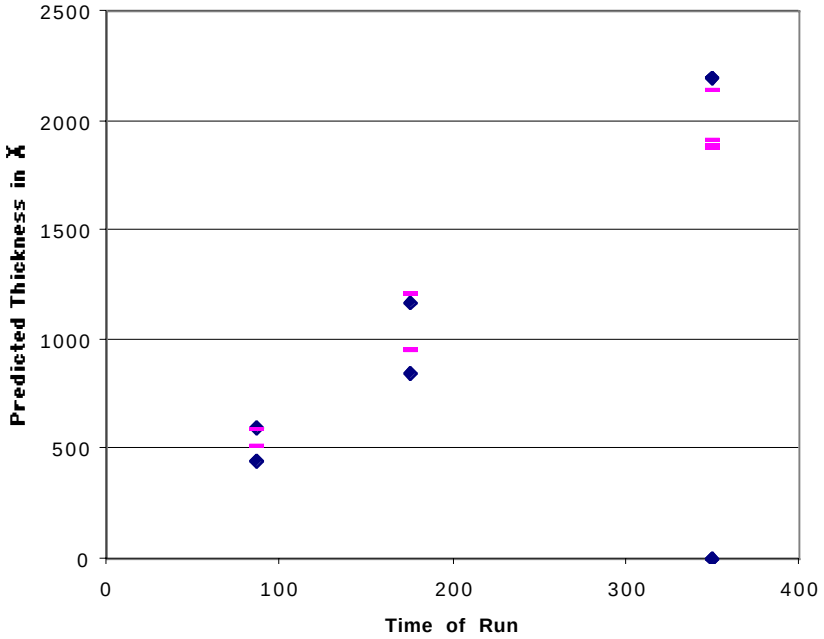


$A=4\pi R^2$

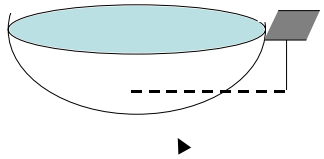
Coatings on shells :

4x less than flats

Scattering => variable factor



Witness Plate not where shells bounce

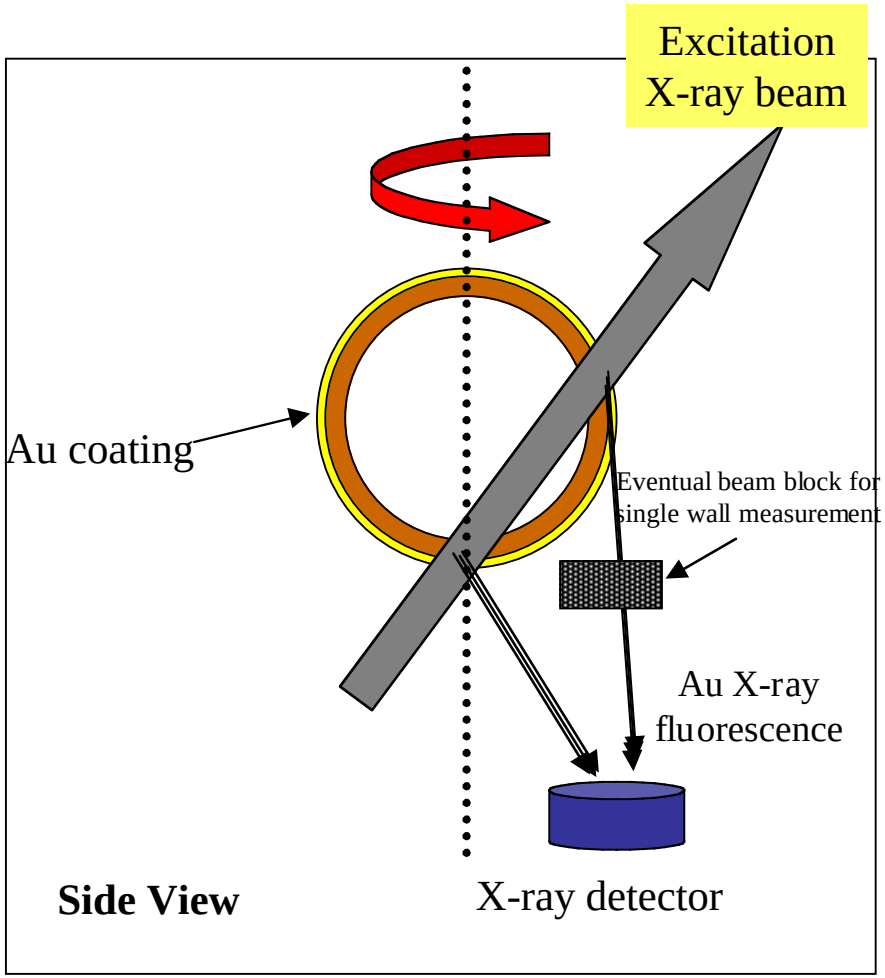


Bounce Pan

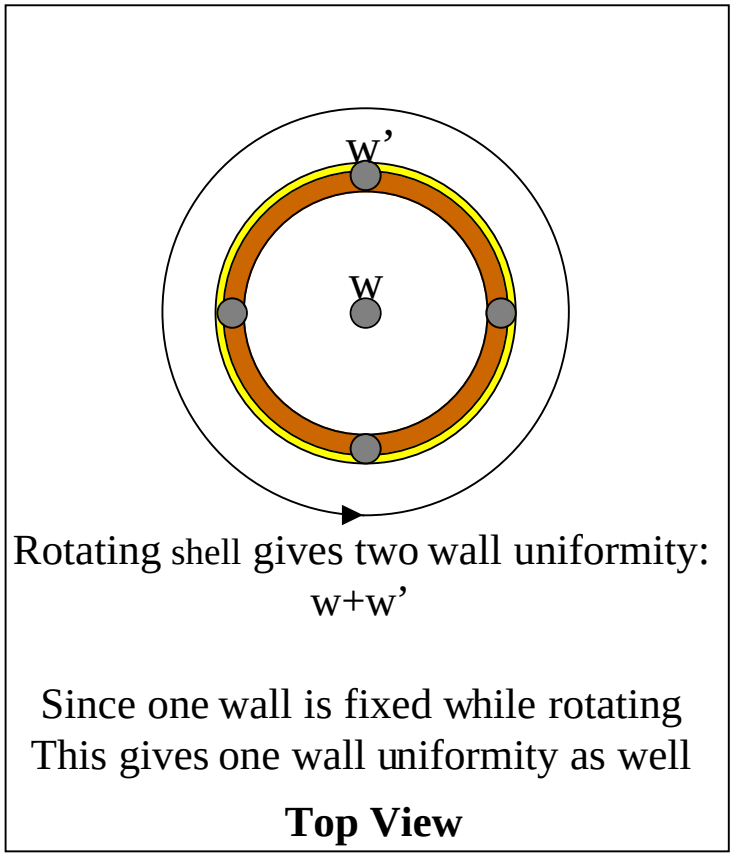
Witness plate measurement is an indirect measurement of thickness on shells

X-ray fluorescence (XRF) can give a direct measurement

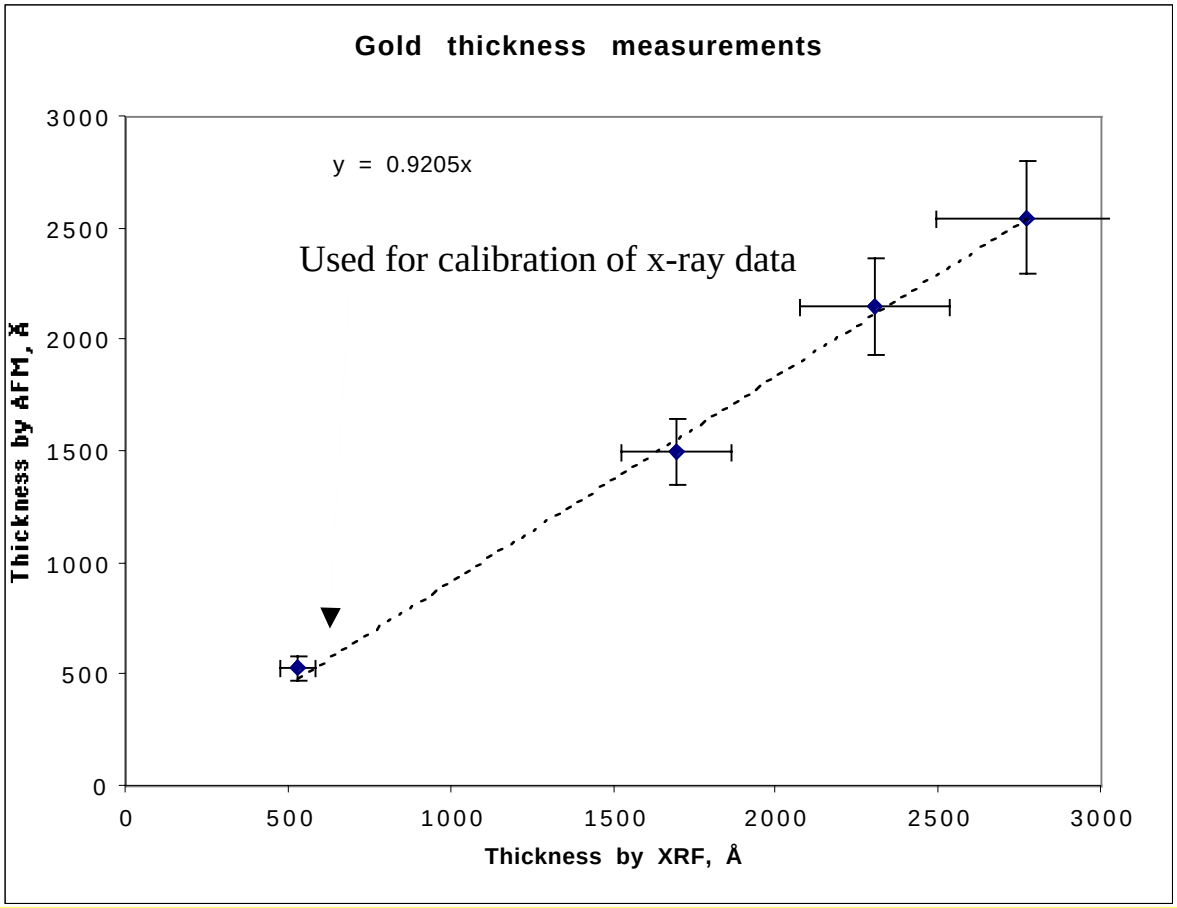
X-ray fluorescence measurements allow more accurate determination of high Z coating thickness and uniformity



Two wall Au fluorescence
Polymer shell x-ray absorbance is negligible



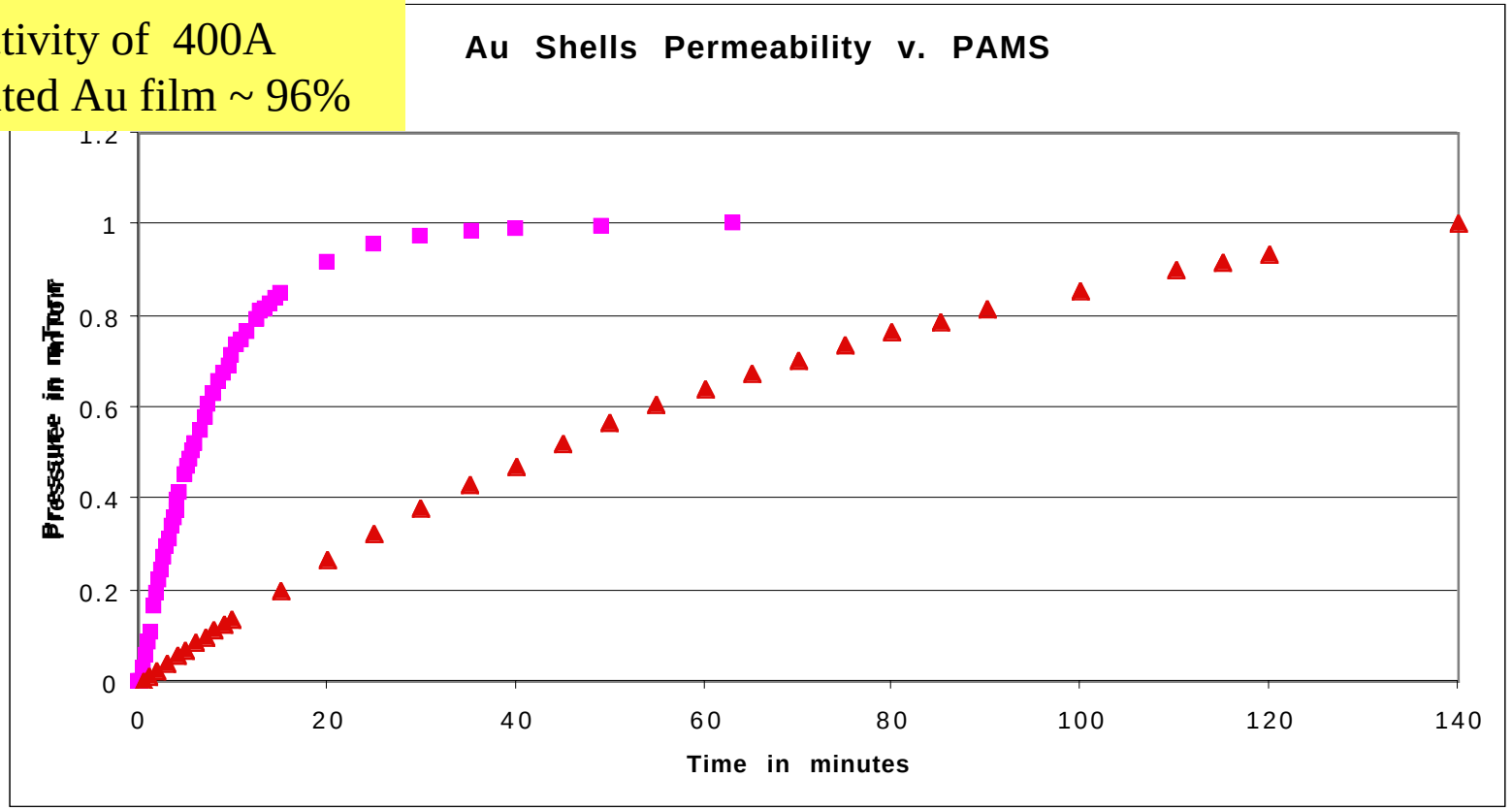
X-ray fluorescence measurements were calibrated against atomic force microscope measurements



X-ray fluorescence gave an accurate measure of gold thickness on flats (calibrated against AFM)
Error bar are self-imposed limits of ± 10%

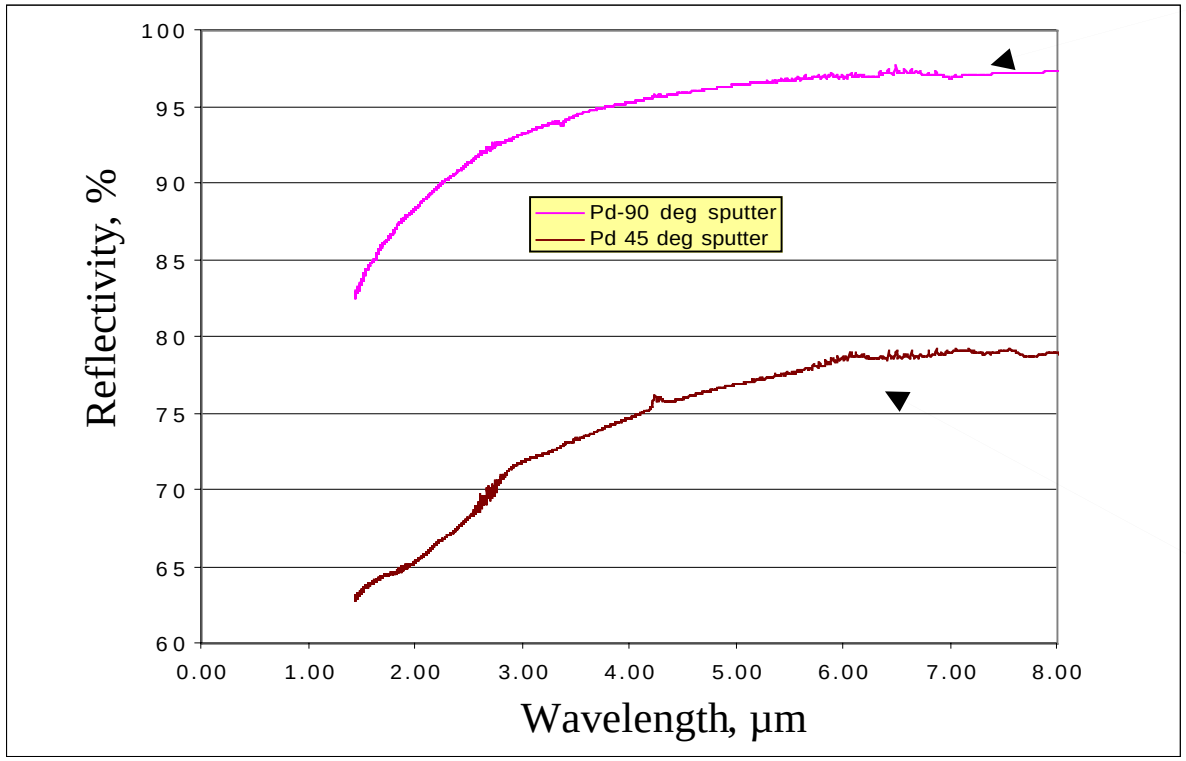
Gold coated shells were permeable to He and D_2 …

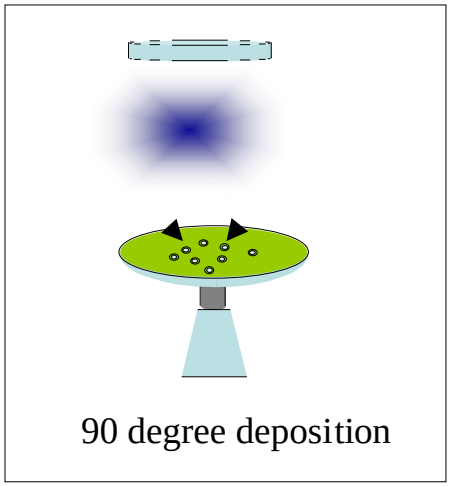
Reflectivity of 400A deposited Au film ~ 96%



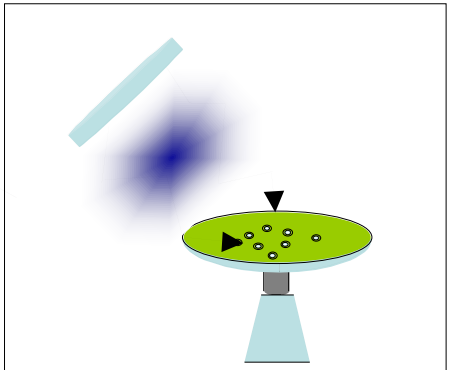
… however, permeation time approx. 6-10 times longer than the polymer ~ 220-390 A coating

Deposition conditions can dramatically affect reflectivity of coatings



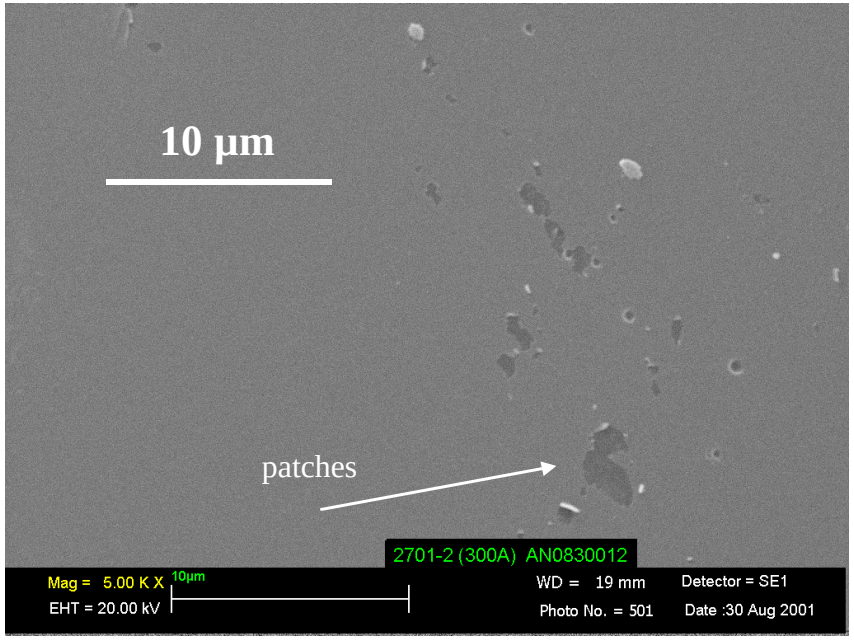


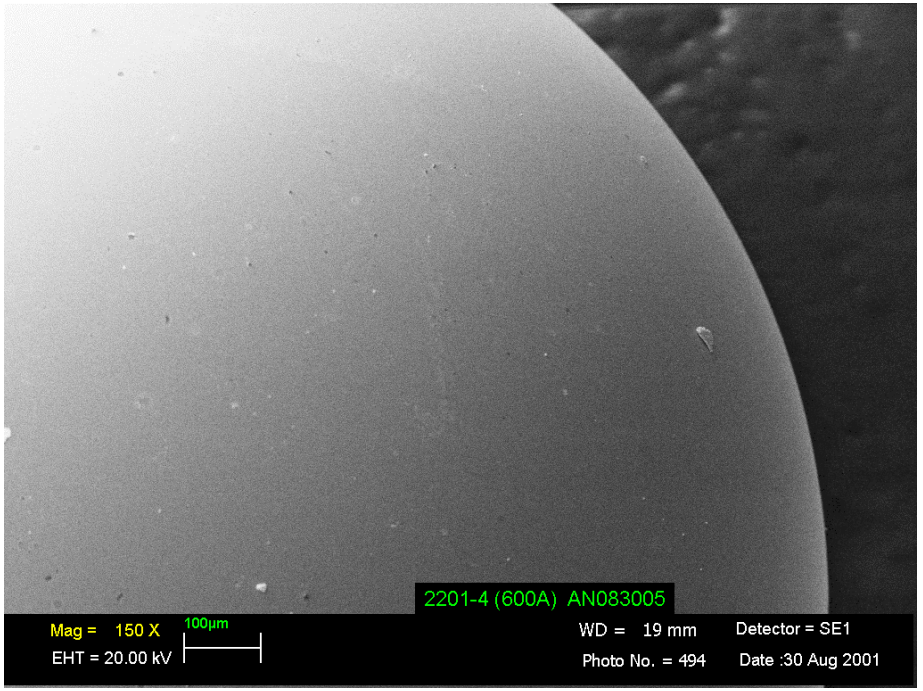
90 degree deposition



45 degree deposition
Used in co-sputtering

Shell to shell collisions are probably responsible for small defects on shell surfaces





Elimination of these defects needs to be studied

High Z coatings of a number of different compositions have been made

Permeability	Coating	Au at.%	Pd at.%	Reflectivity
Lower	Au only	100	-	Higher
	Pd only	-	100	
Higher	Au-Pd	51	49	Lower
	Au-Pd	69	31	
	Au-Pd	79	21	
	Pd+ 80 A Au	15	86	