



# Diffusion Barrier Coatings

## ITER EDA R&D

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Sandia is a multiprogram laboratory operated by Sandia Corporation, a Lockheed Martin Company, for the United States Department of Energy's National Nuclear Security Administration under contract DE-AC04-94AL85000.





# Outline

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- **There was a desire early in the ITER EDA to develop a soft solder layer between PFM and heat sinks to facilitate maintenance.**
- **The US worked on low melting Sn based solders and looked for coatings to put on copper to prevent attack.**
- **The notion was dropped by ITER before completion of the R&D but good coatings were found.**



# Samples for corrosion testing

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- **Indentations (3.2 mm deep) were made in copper plates**
- **The indentations were coated with various diffusion barriers**
  - **50  $\mu\text{m}$  of Al (with and without 5000 A Ni)**
  - **10  $\mu\text{m}$  of Cr (with and without 5000 A Ni)**
  - **10  $\mu\text{m}$  of Nb (with and without 5000 A Ni)**
  - **10  $\mu\text{m}$  of Ti (with and without 5000 A Ni)**
  - **10  $\mu\text{m}$  of Ta (with and without 5000 A Ni)**
  - **10  $\mu\text{m}$  of Mo (with and without 5000 A Ni)**



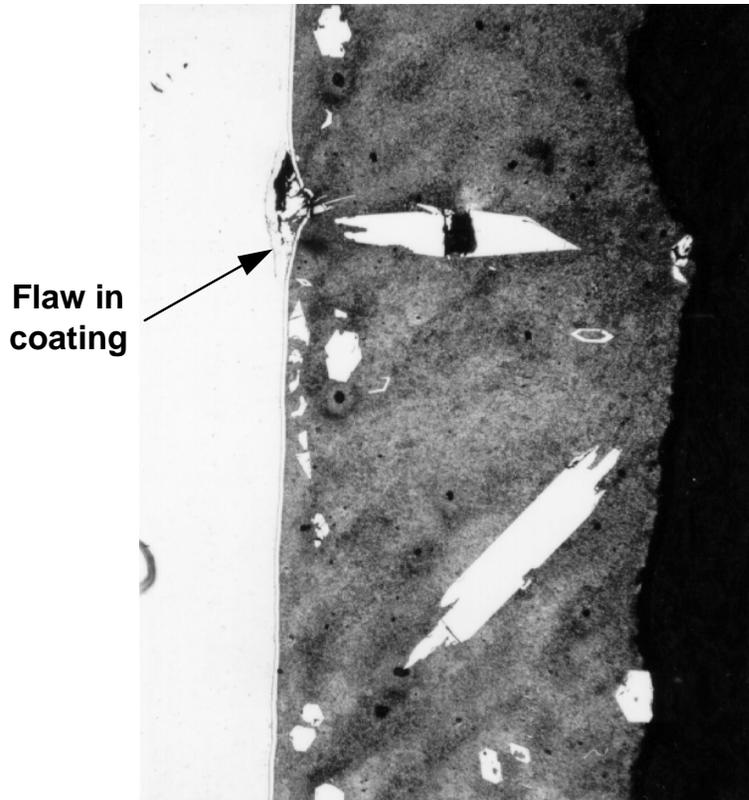
# Results

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- **After 156 hours at 350 C there was evidence of attack of the copper at defects in the coatings**
- **After 504 hours there was complete failure of all barriers because of the defects**
- **In some instances failure was due to poor substrate adherence of the coating**

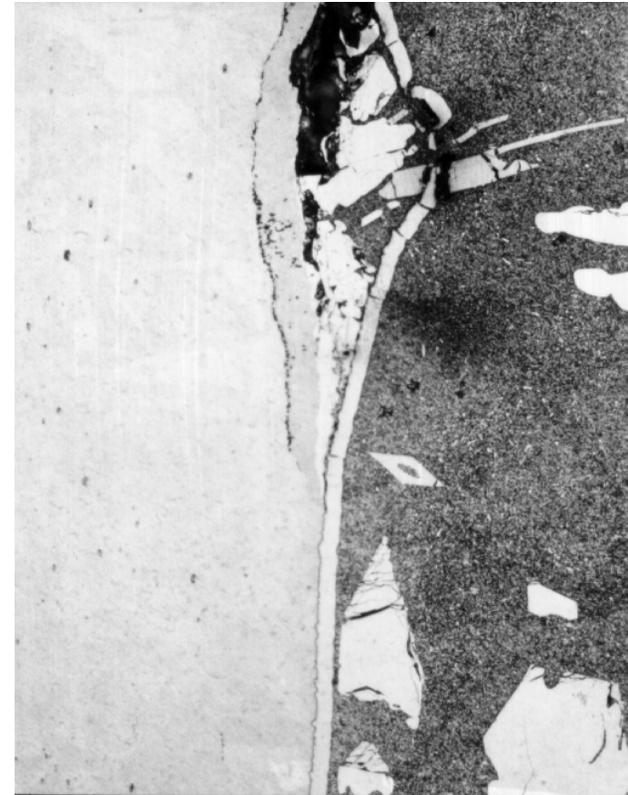
# Attack at a Defect in Coating

After 156 hrs



Cu Cr Sn 50x

After 156 hrs



200x

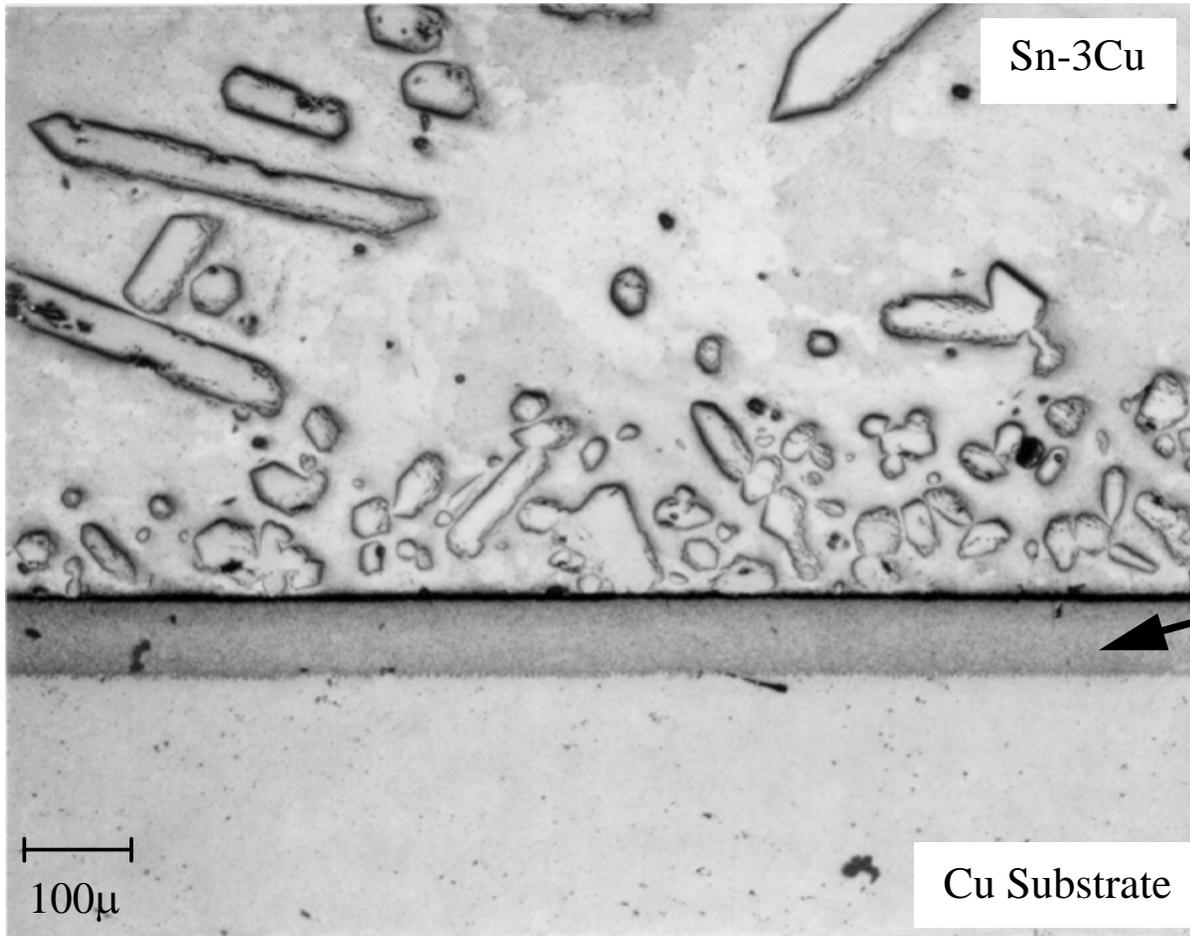


## Second Test cycle

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- The most promising coating Cr was applied as a 80  $\mu\text{m}$  coating
- The samples were aged at 250C for up to 504 hours
- No failures were observed.

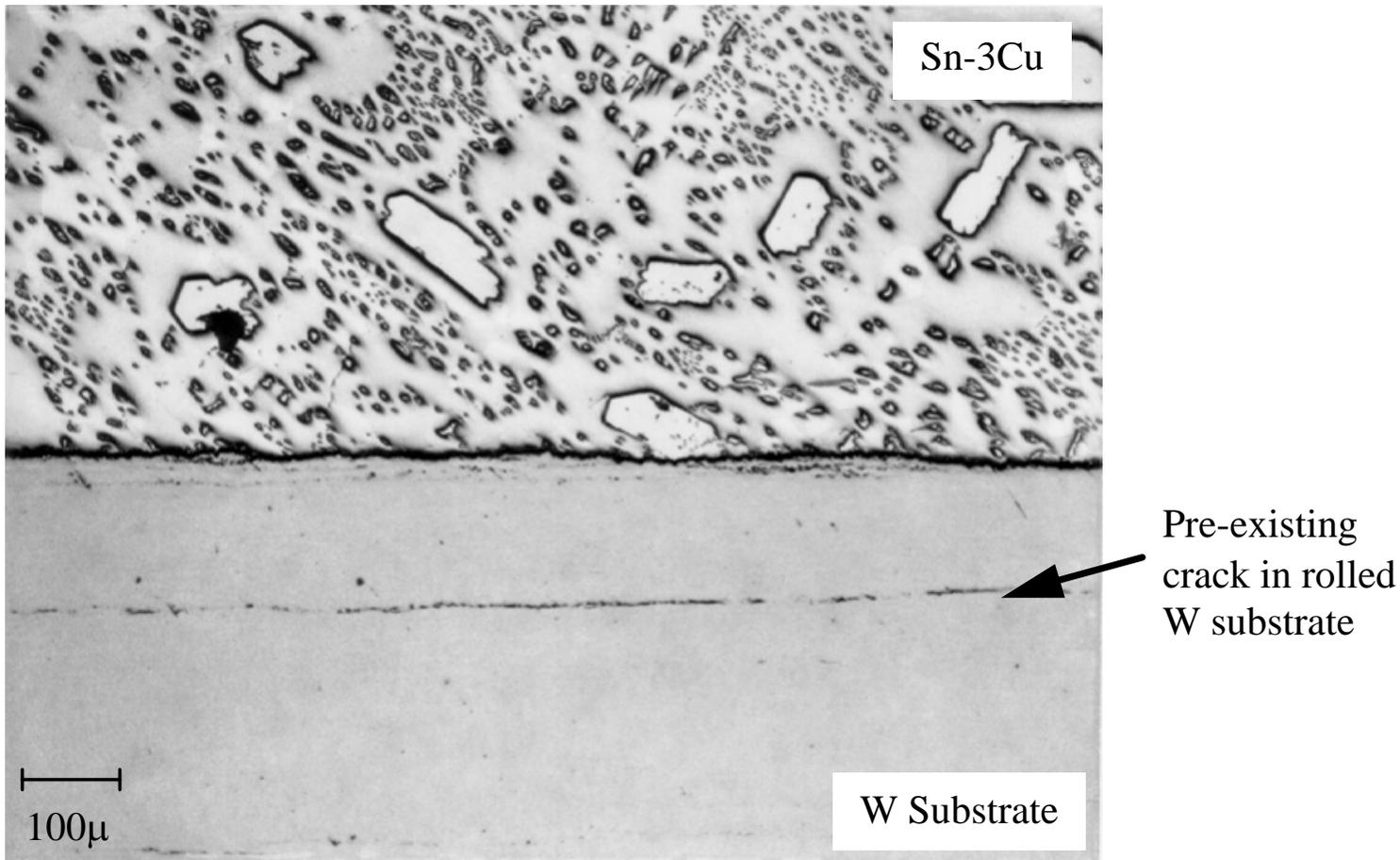
# No Attack with Thick Coating



Electroplated  
Cr-Layer with  
Ni-Overcoat

Aging Conditions: 250°C for 504hrs

# No Attack of W substrate



Aging Conditions: 250°C for 504hrs



# Conclusions

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- **Flaws in thin diffusion barriers can lead to failure of the barrier and attack of the substrate**
- **Electroplated coatings of at least 80  $\mu\text{m}$  are recommended.**
- **Prototype coatings should be sectioned and examined for defects.**
- **Testing at temperature and the proper material combinations is important**
- **Thermal mismatch between the barrier and the substrate should be limited.**