

# Investigation of anomalous densities of high-energy alpha-particles tracks in CR-39 detectors during electrolysis of heavy water on palladium cathodes.

R. Aina, **U.Mastromatteo**

STMicroelectronics – Via Tolomeo, 1 -20010 Cornaredo (MI)

# Oriani's claims

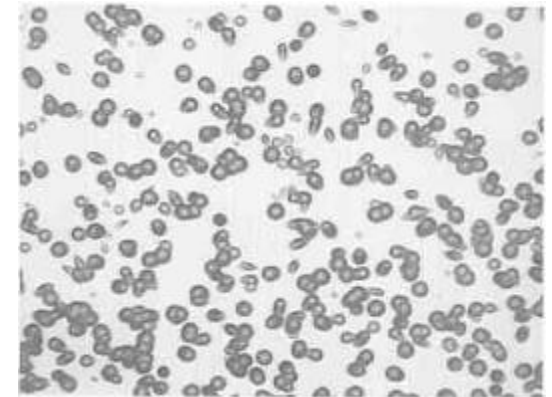
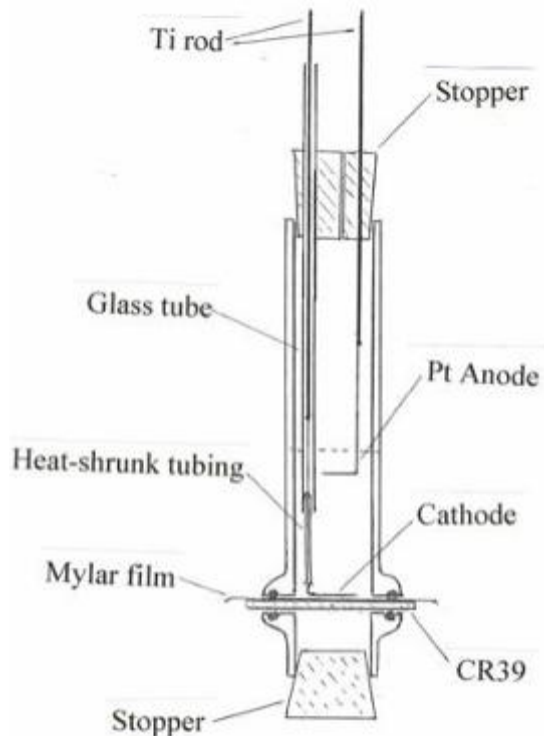
## Abstract

A relatively simple technique using CR39 particle detectors has been developed that in 25 consecutive electrolyses has reproducibly produced charged particle tracks, showing unambiguous evidence of a nuclear reaction during electrolysis of heavy or light water solutions. Nuclear tracks can be produced upon the surface and beyond the 1 mm thickness of the CR39 detectors. Nuclear activity of some sort can persist in the Viton o-rings used in the electrolysis cell so that charged energetic particles can be generated subsequently without electrolysis.


# Repeatable technique for the generation of a nuclear reaction during electrolysis

R.A Oriani

University of Minnesota, 151 Amundson Hall, 421 Washington Ave SE, Minneapolis MN 55455 email: orian001@umn.edu



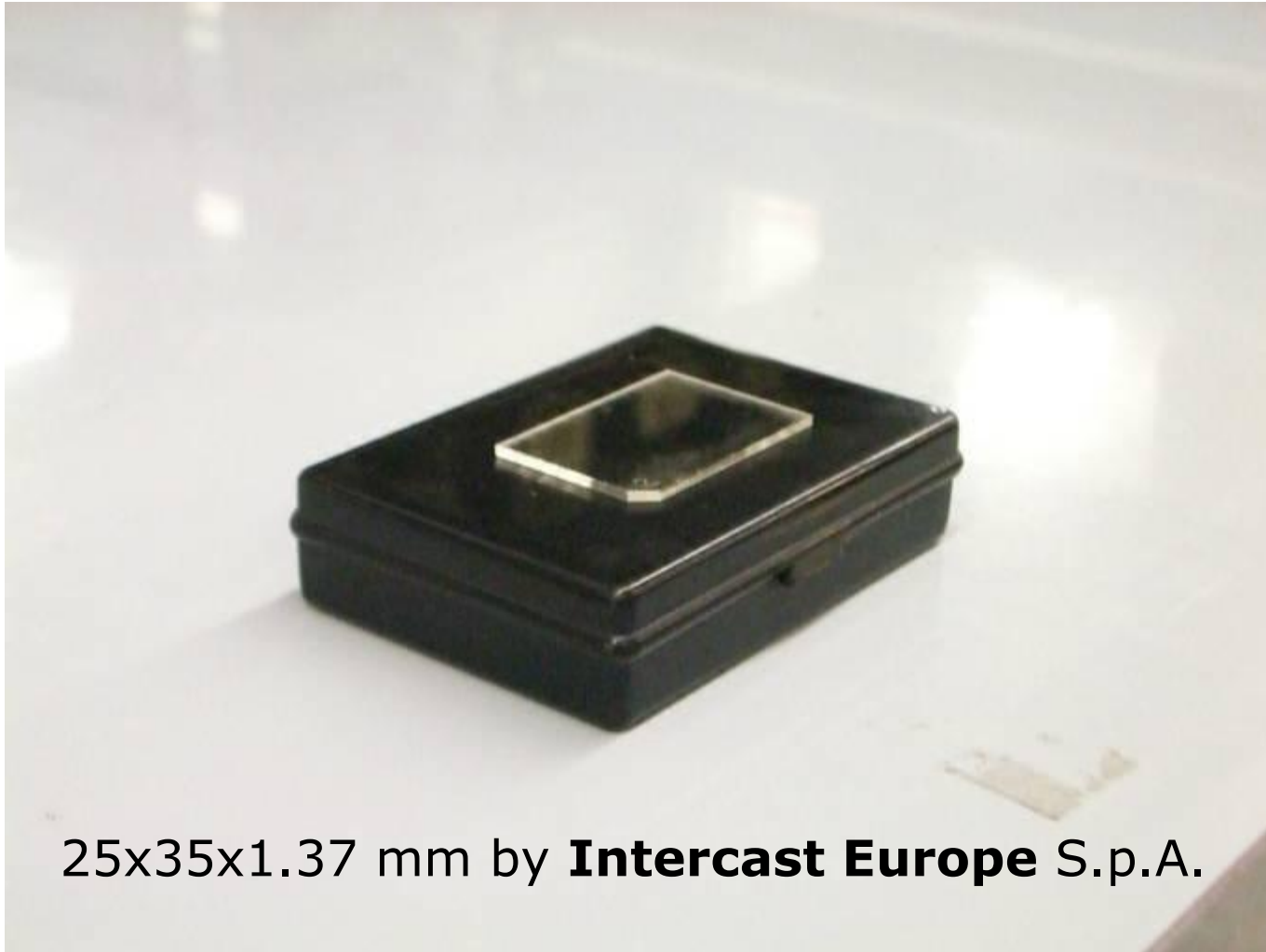
# Oriani's results

 Examination showed that haze patterns following the circumference of the o-rings had developed, similar to that illustrated by Fig.5. However, the central regions of the areas bounded by the haze rings were clear. The track densities were 55 tracks/cm<sup>2</sup> on one chip and 70 on the other. These numbers are to be compared with the background value of 55 per cm<sup>2</sup> and with over 2000 tracks /cm<sup>2</sup> found in the center of the chip pictured in Fig.5.

# AIM OF EXPERIMENT

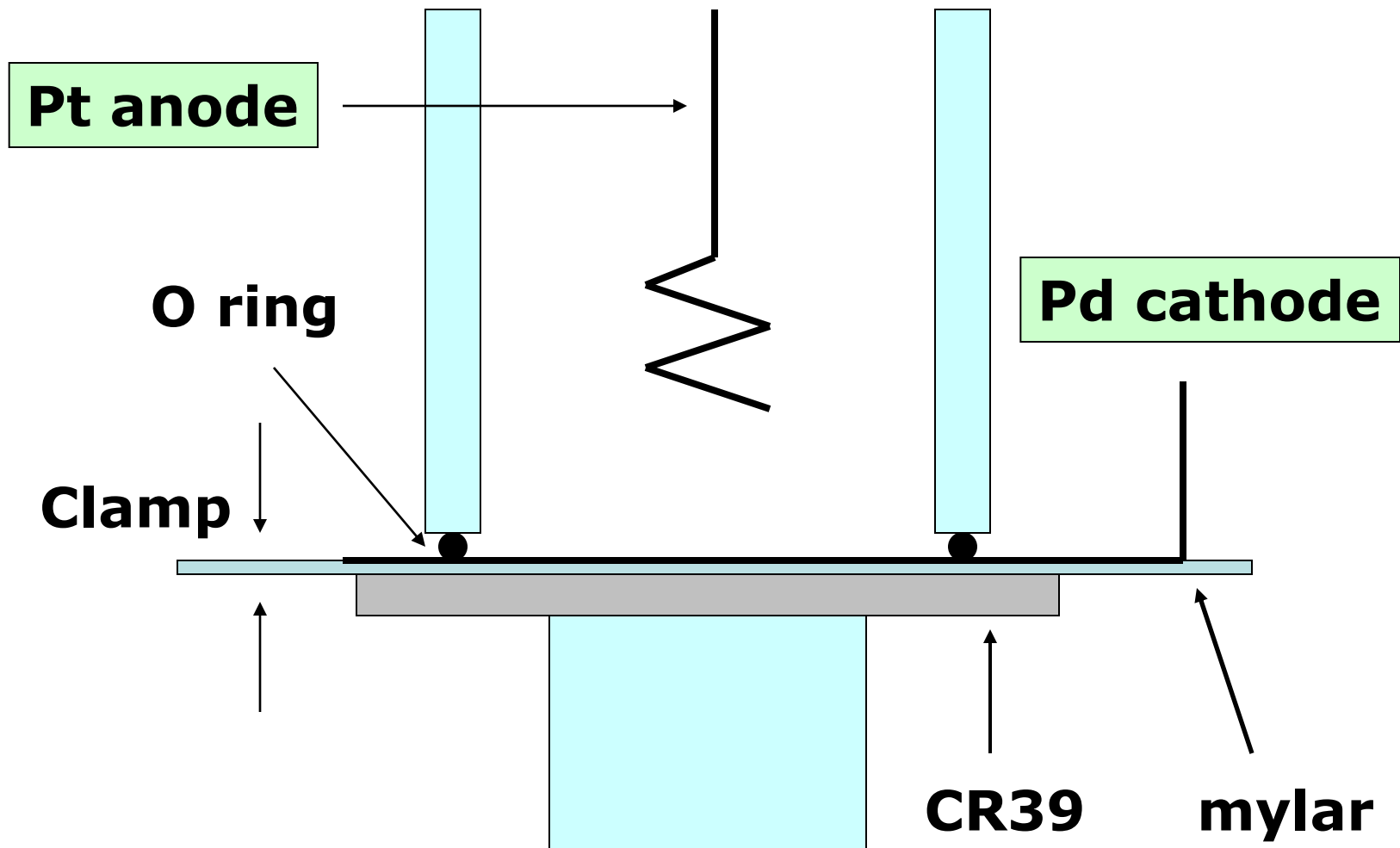
- To detect alpha particles emission from Pd cathode during electrolysis D loading using a standard plastic detector for measurements of radon in the environment
- Expected tracks density from Pd cathode should be significantly higher than noise level

# CR 39 TRACK DETECTOR



25x35x1.37 mm by **Intercast Europe S.p.A.**

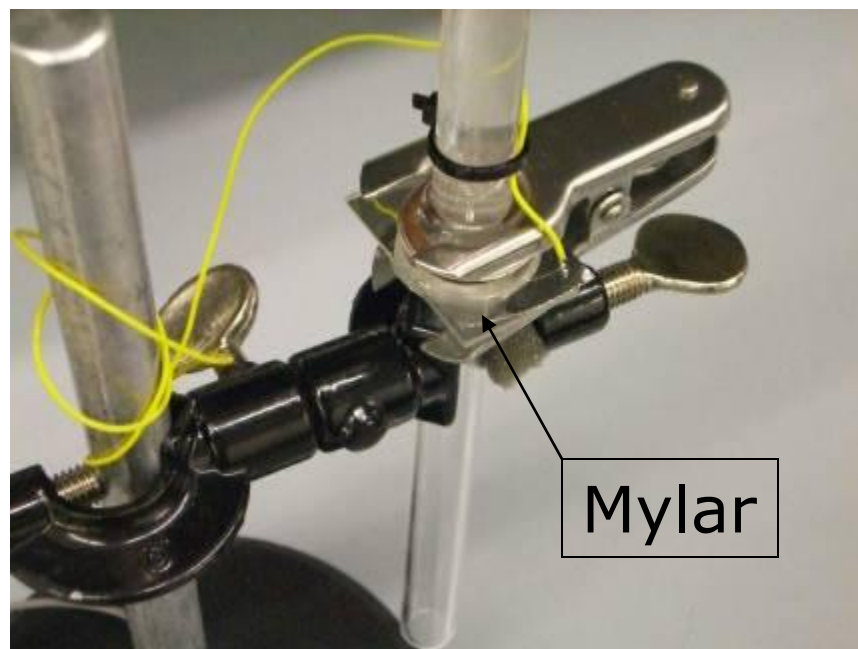
# ELECTROLYSIS CELL



# HIGHLIGHT OF MYLAR - CR39 ASSEMBLY



CR 39



Mylar



# WHY MYLAR?

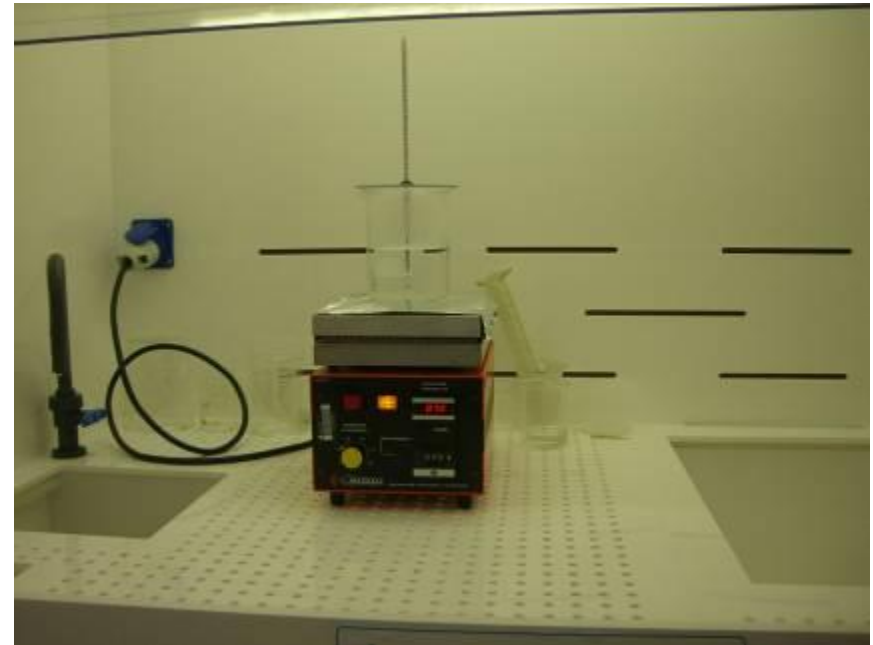
- Mylar interposed between Pd cathode and CR 39 prevents this one to be etched or contaminated by electrolytic solution during D loading
- Artifacts on CR 39 plate can produce wrong interpretation of results. We think this happened in some experiments from others experimentalist

# ELECTROLYSIS PARAMETERS

- ▣ LiCl 0.5 M in 10 mL D<sub>2</sub>O
- ▣ I<sub>c</sub> :10 mA; (~ 0.5 A/cm<sup>2</sup>)
- ▣ Cathode :Pd wire, Ø 50 µm, 12 mm length
- ▣ Anode :Pt spiral wire
- ▣ Mylar 11 µm thick
- ▣ Time: 3 – 7 days

# ETCH CONDITIONS

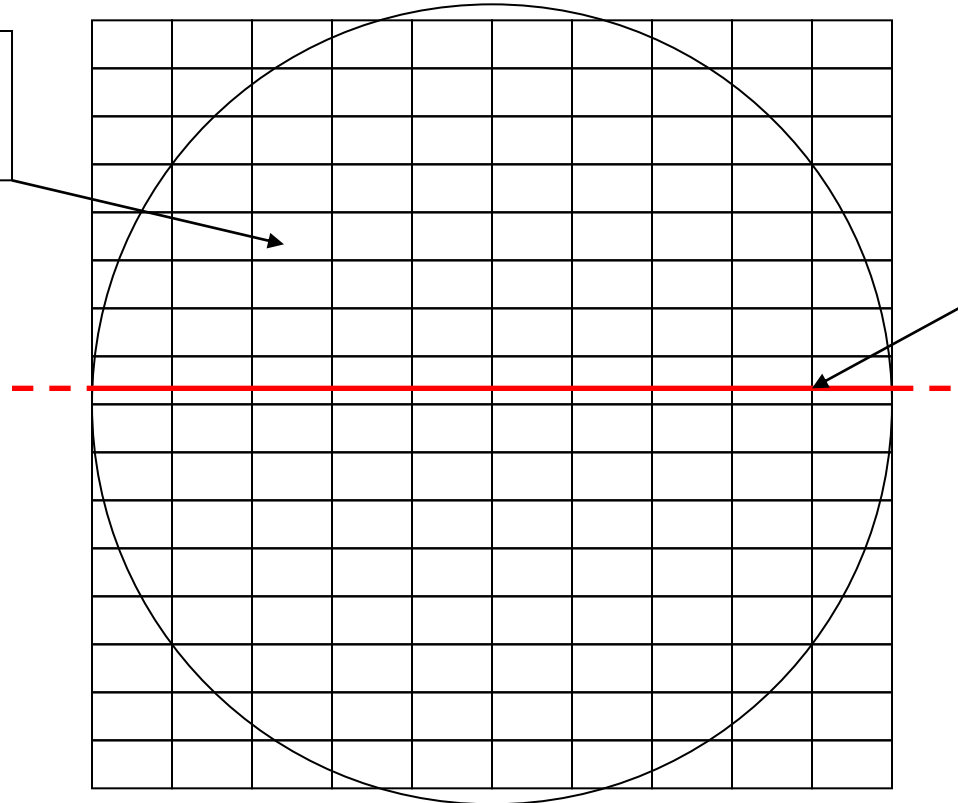
- ▣ NaOH 6.25 M @  
70°C for 6 hours
- ▣ Heating plate with  
electronic  
temperature control
- ▣ Thermometer for  
T° stability check



# FIELD SCAN GRID

Total field area: 1.186 cm<sup>2</sup>

125 boxes  
Inside circle

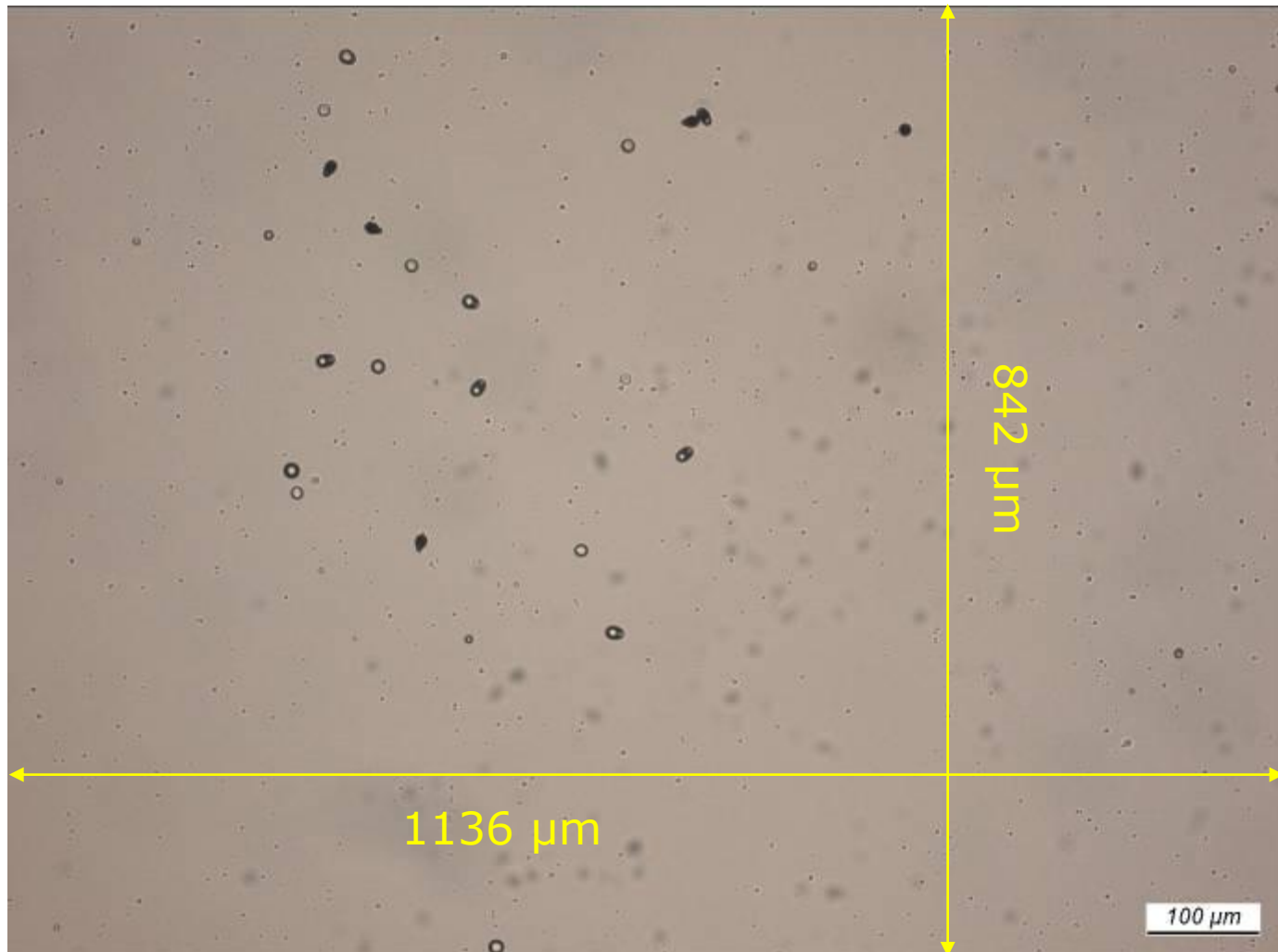


Pd wire

Circular field  
Ø 12 mm

**GOOD FIELDS  
Inside circle**

# BOX SIZE



# TRACKS COUNT SYSTEM



CR39

# BETHE-BLOCK FORMULA

- SRIM<sup>®</sup> and NIST<sup>®</sup> software were used to calculate stopping power  $dE/dx$  and projected range of alpha particles in mylar
- Projected range for alpha 2.50 MeV is 10.99  $\mu\text{m}$
- Alpha particles with  $E > 2.50$  MeV cross mylar and leave tracks on CR 39 11  $\mu\text{m}$  th.

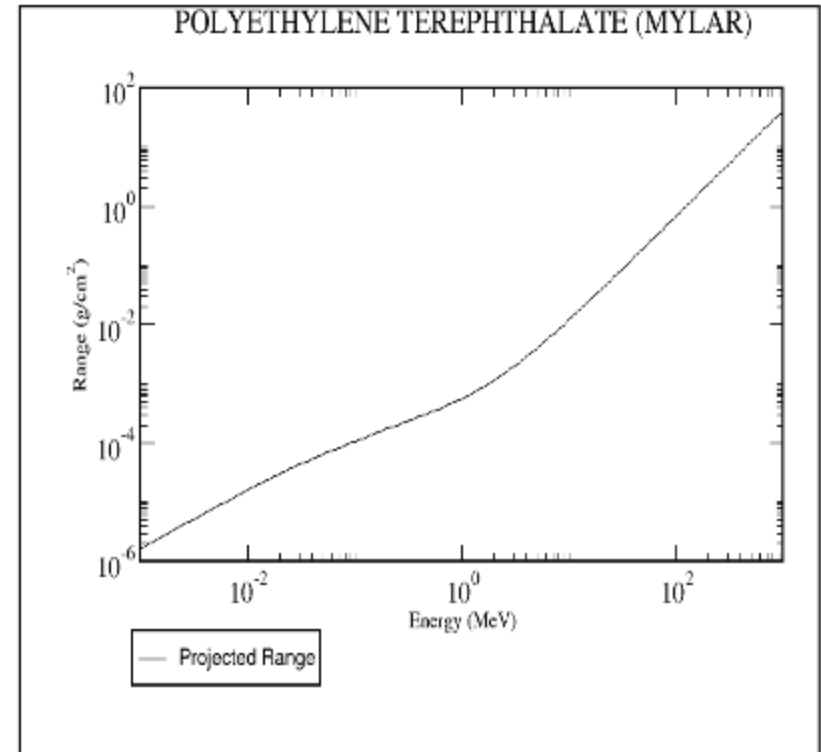
# POLYETHYLENE TEREPHTHALATE (MYLAR)

## COMPOSITION:

Density (g/cm<sup>3</sup>) = 1.40000E+00

Mean Excitation Energy 78.700000 (eV)

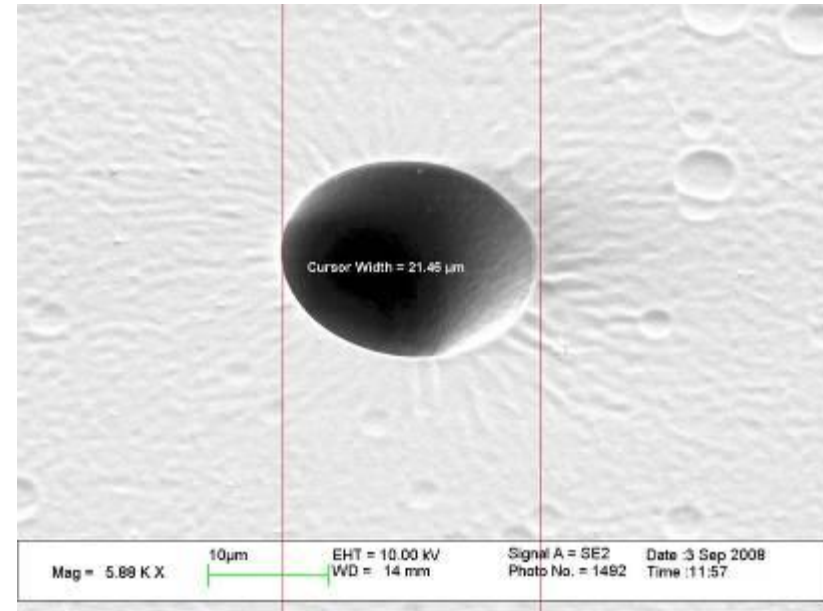
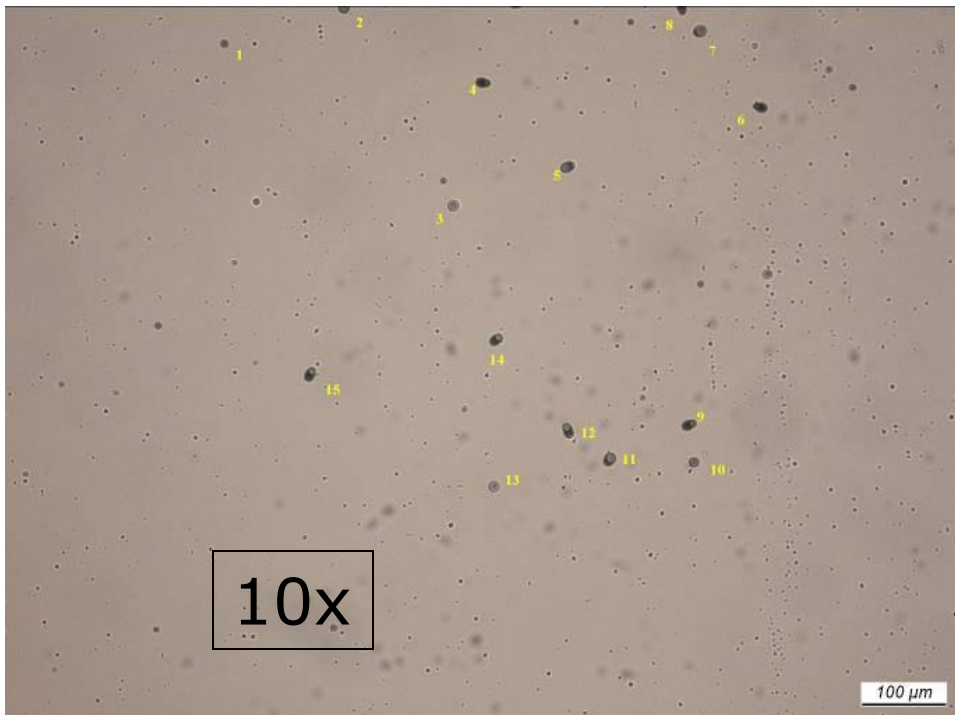
Atomic number	Fraction by weight
1	0.041959
6	0.625017
8	0.333025



$$\text{Range} = \rho x$$



# CR 39 TRACKS AFTER ETCH

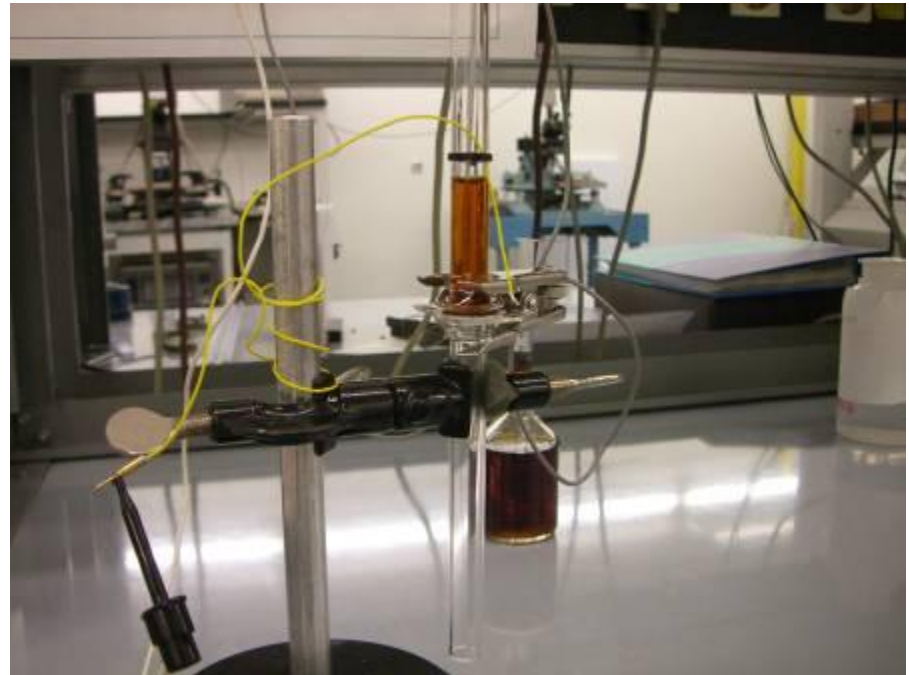


# MATRIX OF TRIALS

- ▣ 2 Blank Test with  $D_2O + LiCl_2$ ; NO ELECTROLYSIS
- ▣ 5 Electrolysis Test with  $D_2O + LiCl_2$
- ▣ 2 Electrolysis Test with  $D_2O + LiCl_2 + PdCl$
- ▣ 1 Electrolysis Test, NO MYLAR

# CODEPOSITION

- ▣ Codeposition of Pd / D from  $\text{PdCl}_2$  in  $\text{D}_2\text{O}$
- ▣  $\text{PdCl}_2$  0.05 M + LiCl 0.5 M
- ▣ Trial 1: 10 mA
- ▣ Trial 2: 0.5 mA till total plating, ramp to 5-10-20-40-80 mA



# RESULTS

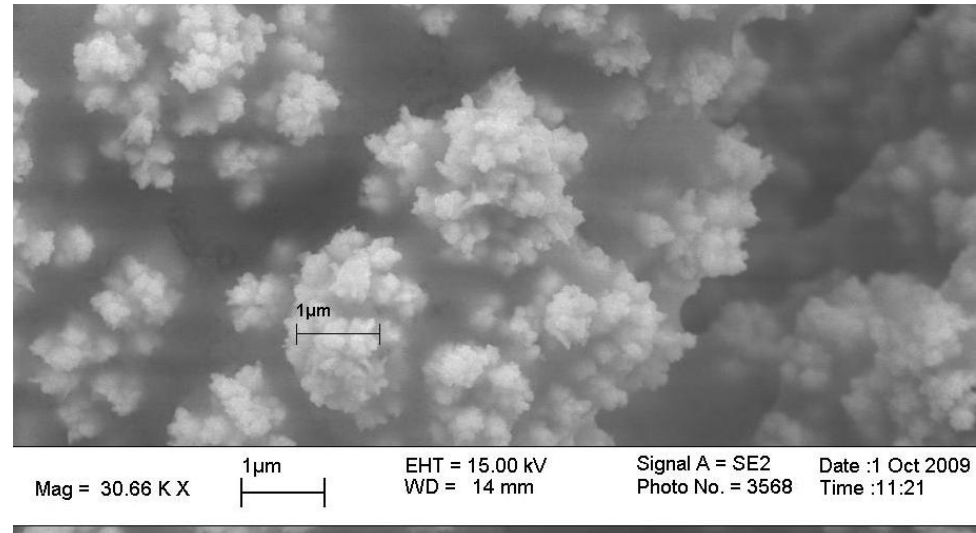
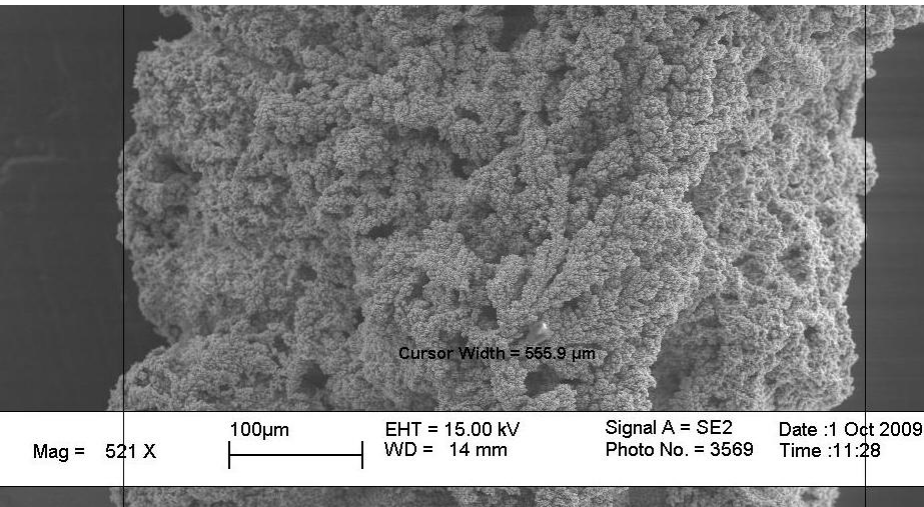
<b>BLANK</b>	
	D (cm <sup>-2</sup> )
EX.1	189
EX.2	154

<b>ELECTROLYSIS</b>	
	D (cm <sup>-2</sup> )
EX.1	222
EX.2	296
EX.3	136
EX.4	112
EX.5	74

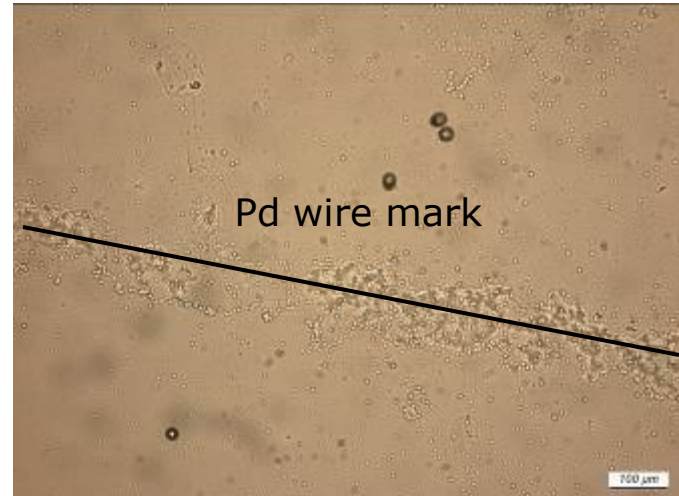
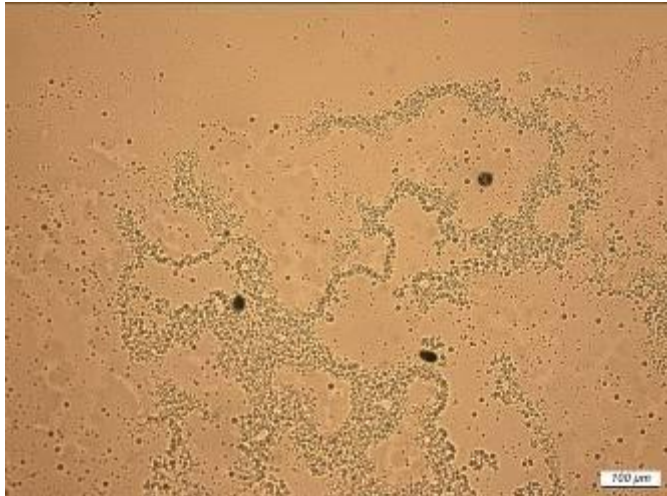
**Tab. 3 – Track Density (Codepos.)**

Exp. -A-	113 tr./cm <sup>2</sup>
Exp. -B-	146 tr./cm <sup>2</sup>

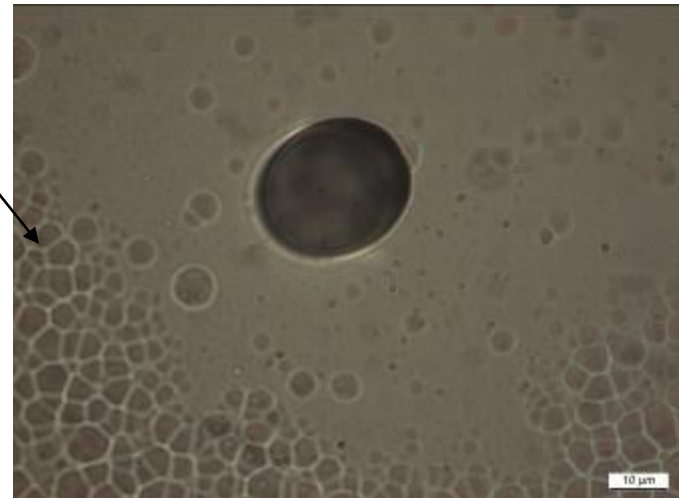
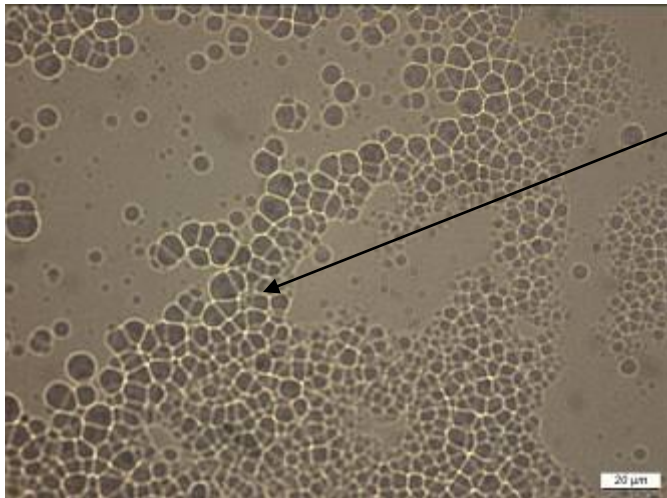
# Pd WIRE AFTER Pd/D CODEPOSITION (SEM)



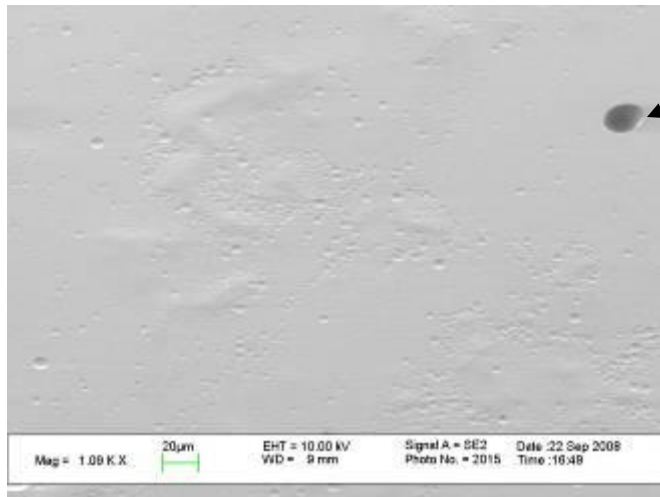
# NO MYLAR - OPTICAL



**"BOUBBLE"  
PITS**

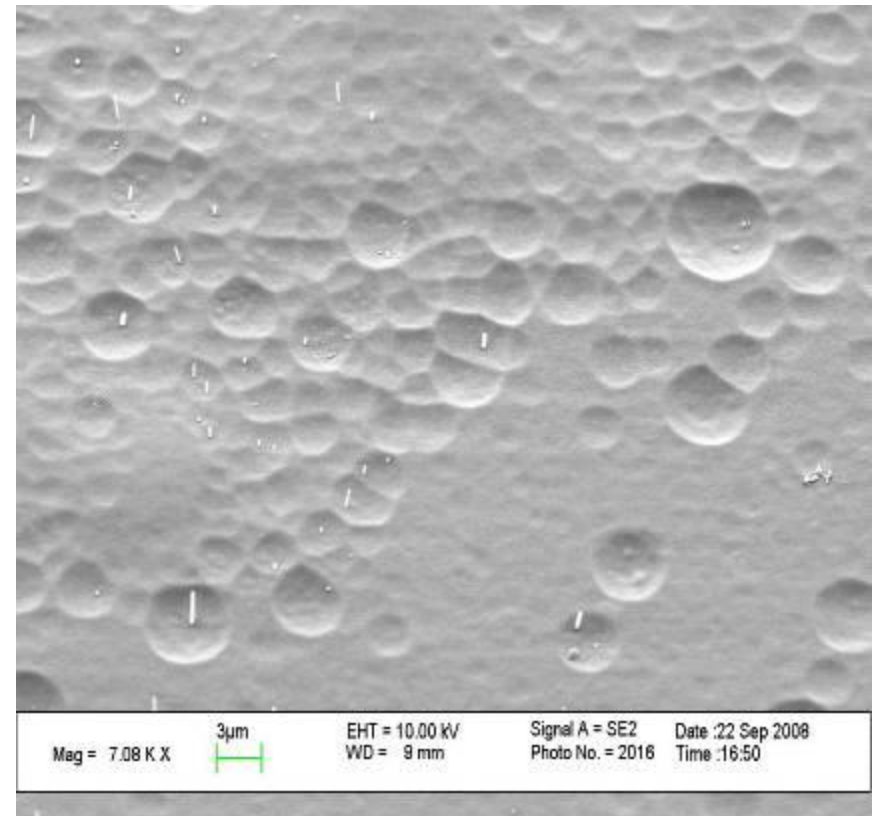
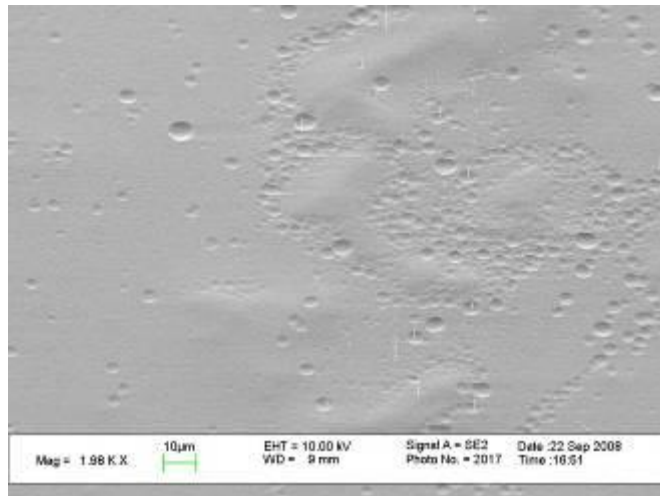


# NO MYLAR - SEM



**TRUE TRACK**

**SURFACE DAMAGE**



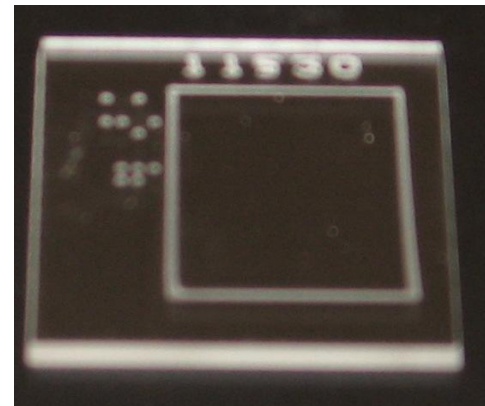
# OBSERVATIONS

- ❑ Experiments with mylar between electrolyte and CR39 give a pit density of same magnitude compared with blank (no current) test; in one case less.
- ❑ Pits appearance in test without mylar is strictly different from nuclear tracks visible on the same chip
- ❑ Under the Pd cathode mark there is not an increase of pit density respect to the neighbor



# CONCLUSIONS

- No meaningful evidence of specific particle emission with  $E > 2.5$  MeV during  $D_2O$  electrolysis (comparable track count), with or without Pd codeposition;
- Similar results reported on site [www.earthtech.com](http://www.earthtech.com)
- New experiments already started with CR39 TASTRAK detectors from “Trak analysis system ltd”



# Acknowledgments

- ▣ Dr. F. Celani of Frascati INFN for Heavy Water and Palladium wire;
- ▣ M. De Pisapia (STMicroelectronics) for SEM analysis and pictures;
- ▣ Dr. G. Iori (InterCast) for CR-39 detectors;

**Thank you for the attention**

**U. Mastromatteo  
STMicroelectronics  
Via Tolomeo,1 – 20010 Cornaredo (MI)**

**ICCF15 - 2009, Roma**

**5-9 September 2009**

