

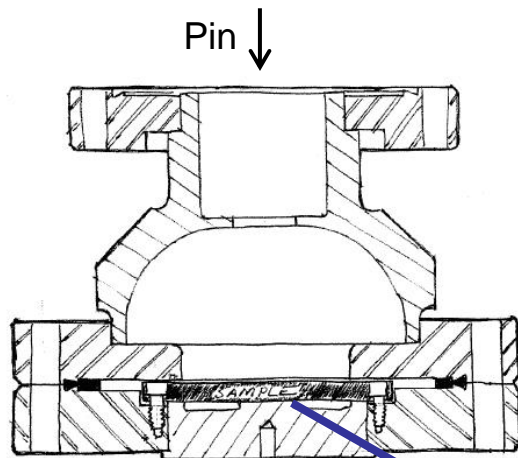
## Pulse Heating Experimental Testing at SLAC

**SLAC KLYSTRON DEPT:** L. Laurent, J. Eichner, E. Jongewaard, C. Pearson, C. R. Tally, B. Vanderzyl, Yoneda, J. Zelinski

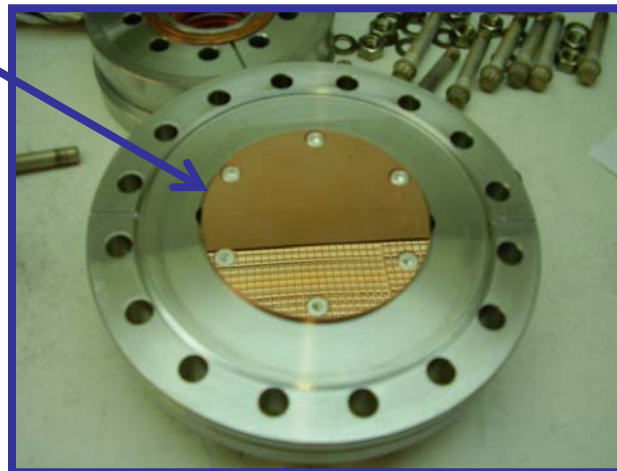
**SLAC:** V. Dolgashev, J. Lewandowski, S. Tantawi, D. Yremian

**CERN:** S. Heikkinen

**KEK:** Y. Higashi



3-inch diam. pulse heating sample



## Pulse Heating Sample Status and Inventory (Sept 2008)

Pulse Heating Sample	RF Tested	Que	Comments
Cu1-1 (CERN)	✓		Reported on at KEK
Cu1-2 (CERN)	✓		Reported on at KEK (Sent to CERN)
CuZr1-2 (CERN)	✓		Reported on at KEK
CuZr1-1 (CERN)	✓		Reported on at KEK
Cu2-1 (CERN)			
CuZr2-1 (CERN)			
CuZr2-2 (CERN)		Next 1	
CuZr3-1 (CERN)			Cold Worked
CuZr3-2 (CERN)	✓	Next 3	Cold Worked
CuZr3-3 (CERN)			Cold Worked
HIP1 Cu (KEK)		In Test	Hot Isostatic pressed
HIP2 Cu (KEK)	✓		Hot Isostatic pressed
E-Deposited Cu (KEK)	✓		Electro-deposited Cu
Single Crystal Cu (KEK)	✓		
KEK1 (KEK)			Diamond Turned Cu
KEK2 (KEK)			Diamond Turned Cu; Etched
KEK3 (KEK)	✓		Diamond Turned Cu; Etched; H2 Fired
Cu101 (SLAC)	✓		Baseline
Cu102 (SLAC)		Next 2	Baseline
CuCr_101 (SLAC)			Vacuum Fired
CuCr_102 (SLAC)	✓		Not Vacuum Fire

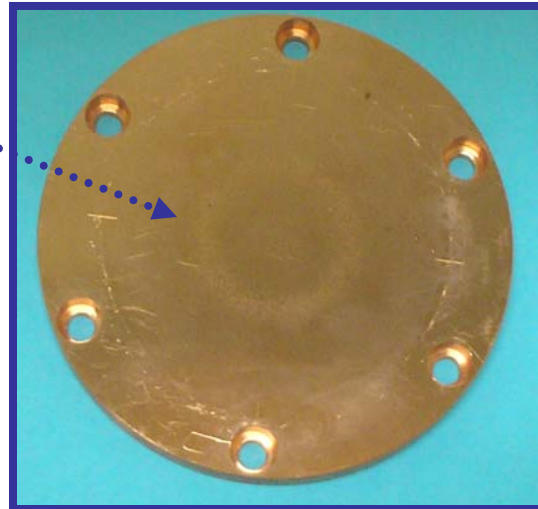
Not Yet Tested =	10	
Total Tested =	11	✓

# 1<sup>st</sup> Four Pulse Heating Samples Fabricated at CERN and Tested at SLAC

Reported on at KEK in May 2008

TE01 Mode  
Pulse Heating  
Ring

Copper: Temp=70°C



Copper Zirconium: Temp=70°C

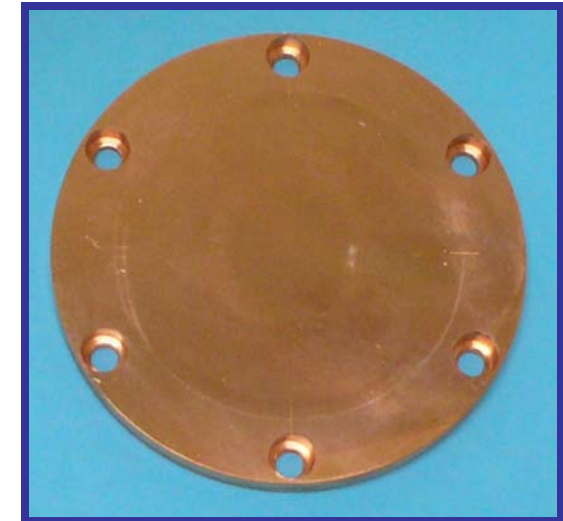


Hardness Test Measurements	
Pulse Heating Samples	HR15T
Cu1-1	78.78
CuZr1-1	59.00
CuZr1-2	58.00
HIP Cu	26.95

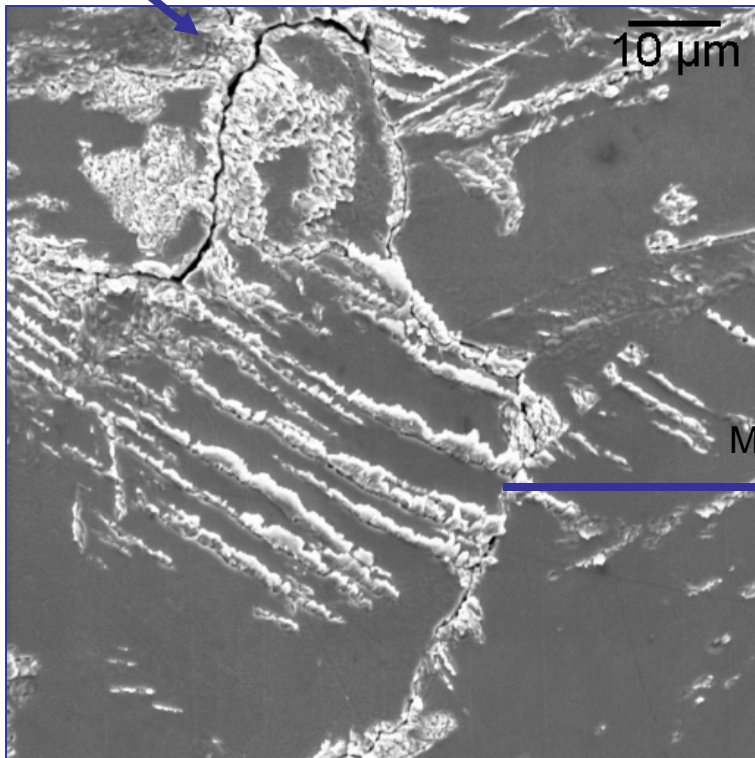
Copper: Temp=110°C



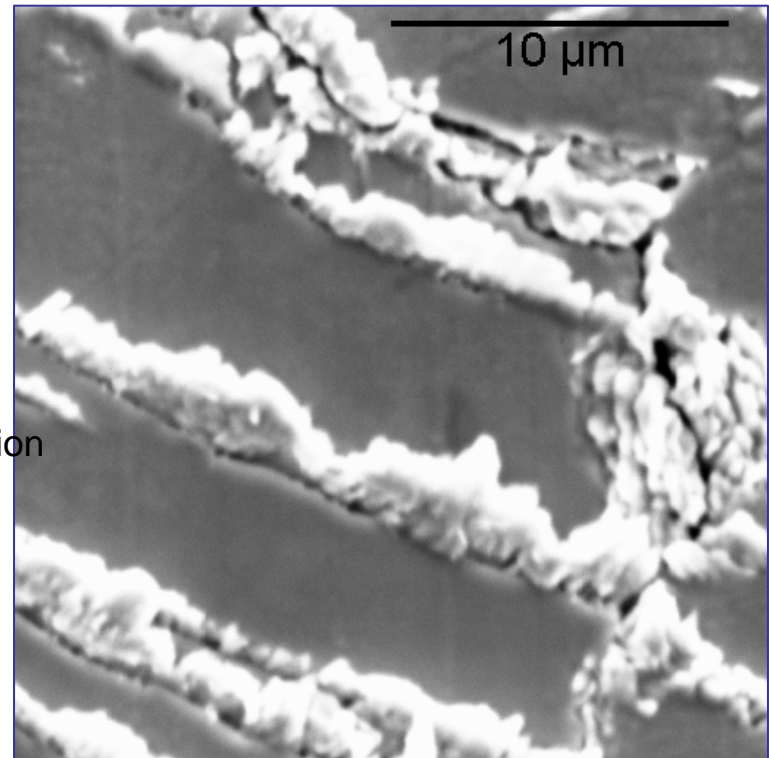
Copper Zirconium: Temp=100°C



Intergranular fracture



High Magnification

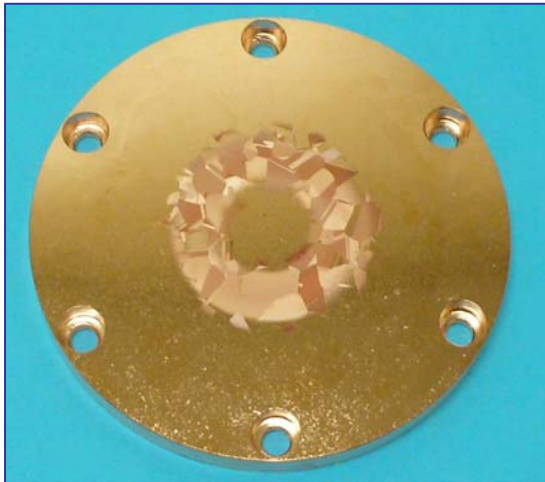


Transgranular fractures

KEK3 Diamond Turned Copper, Etched, H2 Fired (KEK)



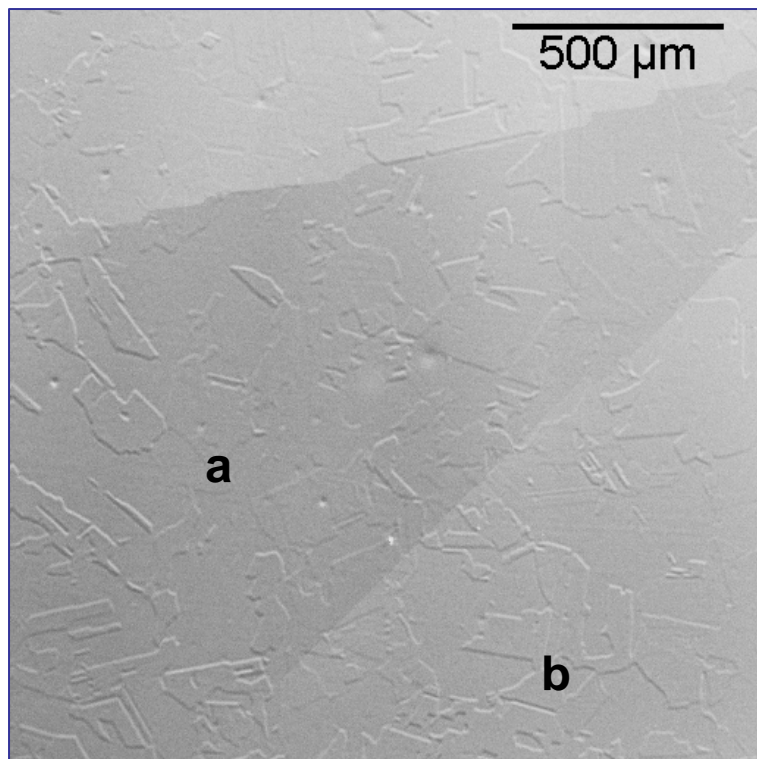
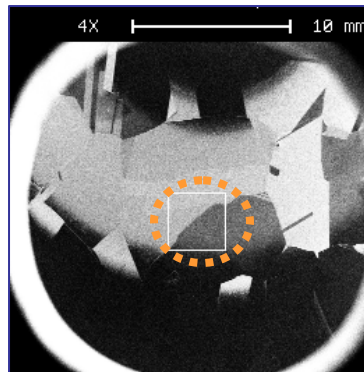
Pre RFTesting



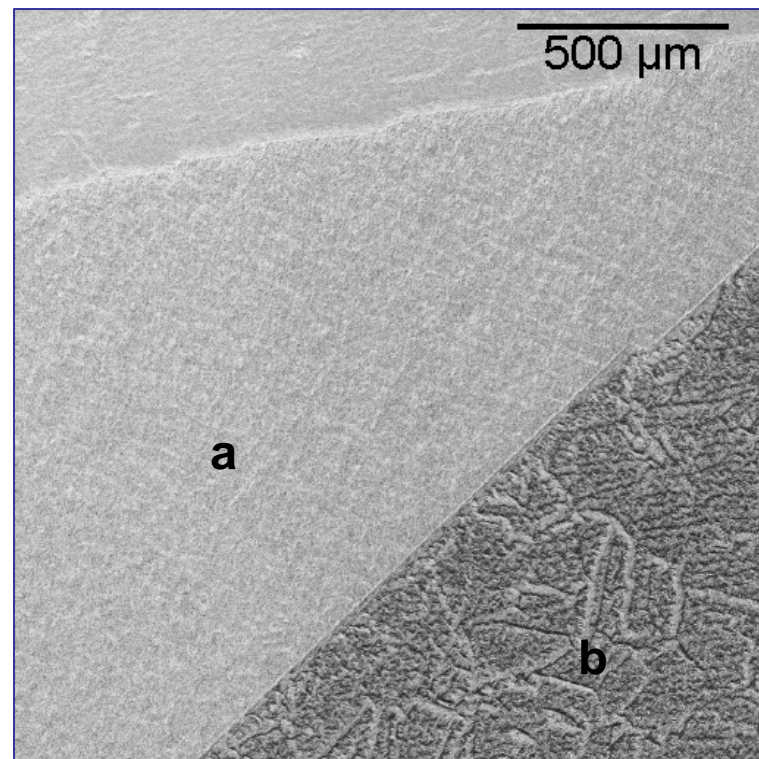
T = 110°C



# KEK3 Diamond Turned Copper, Etched, H2 Fired (KEK)



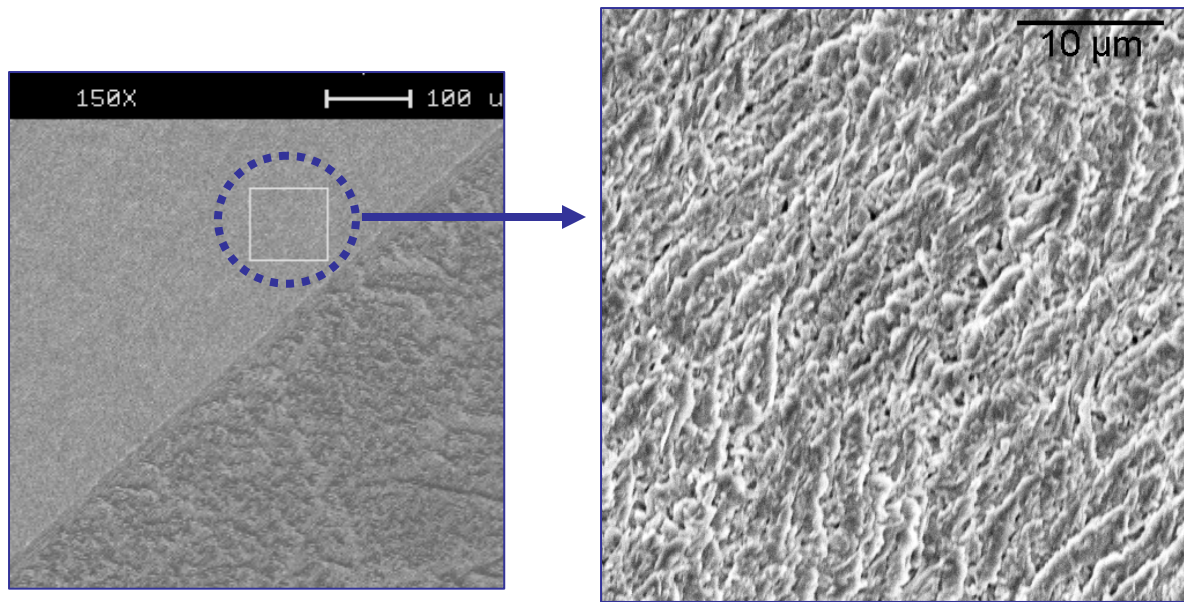
Pre RFTesting



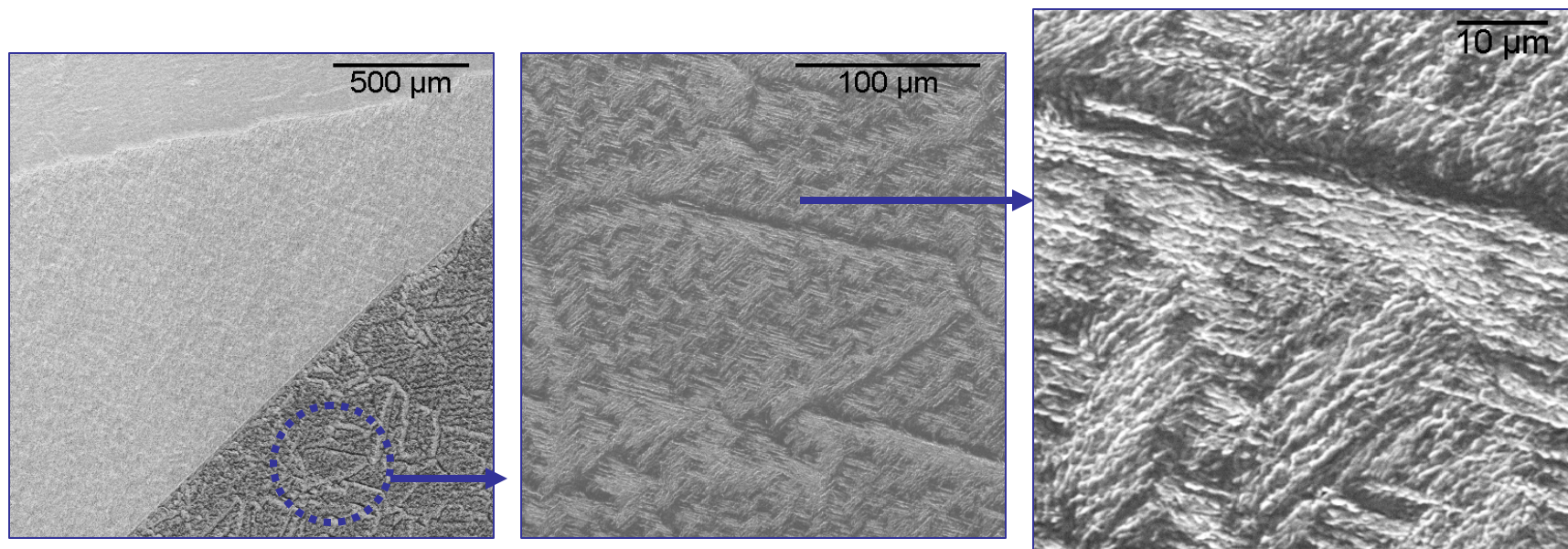
T = 110°C

KEK3 Diamond Turned Copper, Etched, H2 Fired (KEK)

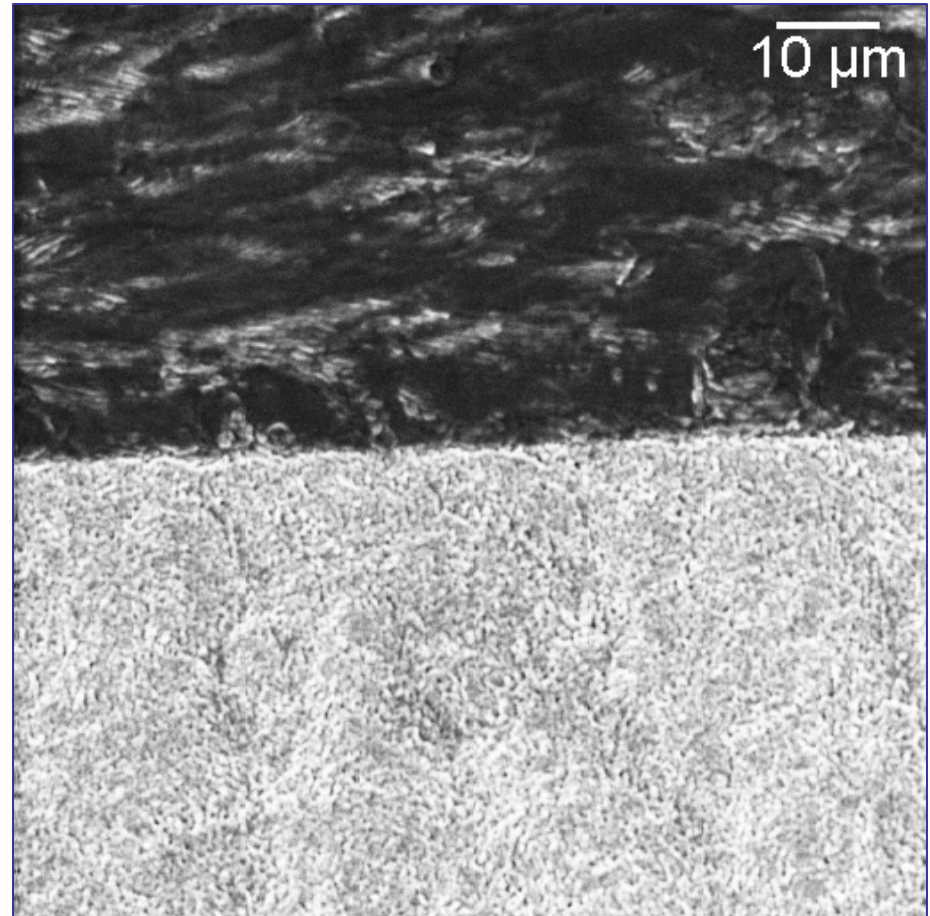
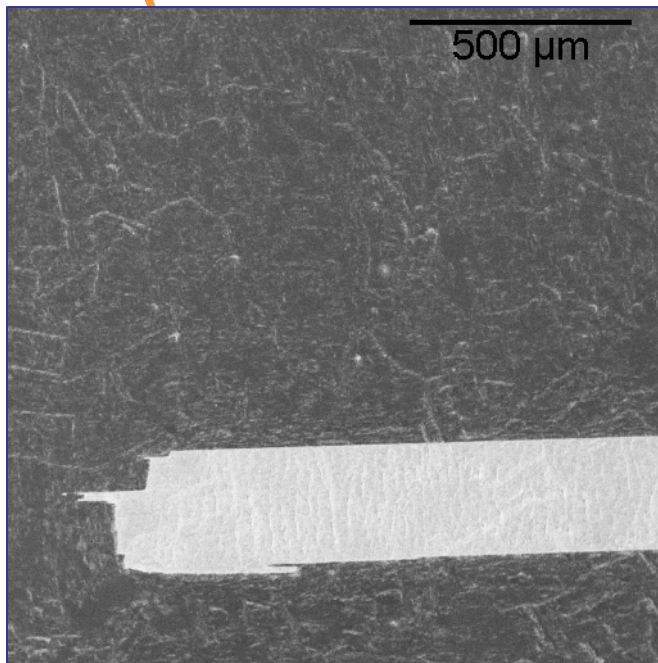
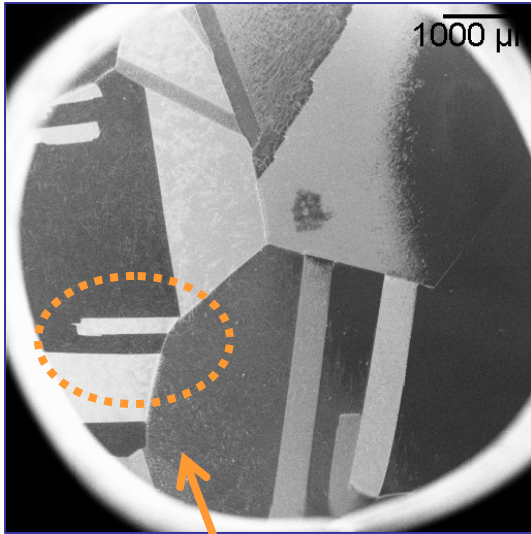
**a**



**b**



KEK3 Diamond Turned Copper, Etched, H2 Fired (KEK)



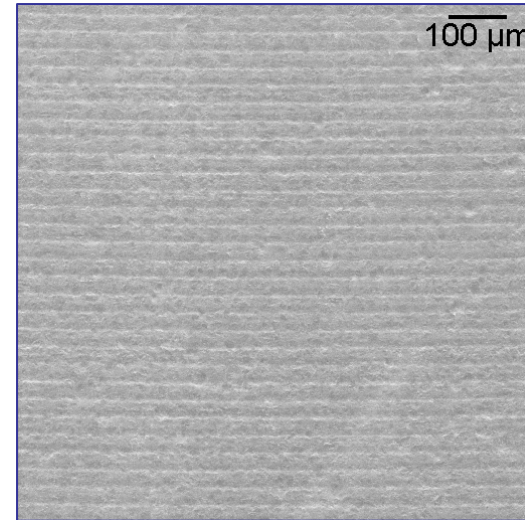
High Magnification Image of Grain Boundary



# Electro-Deposited Cu (KEK)



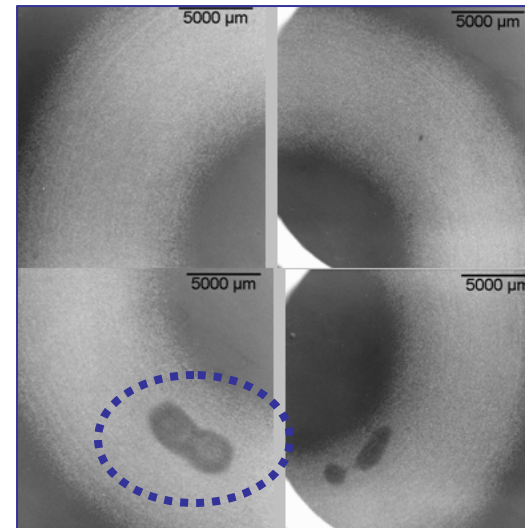
Pre RF Test



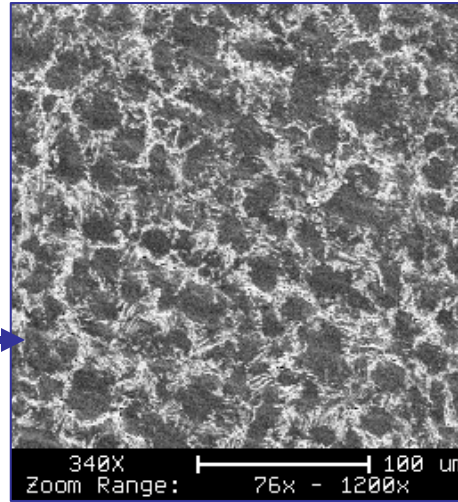
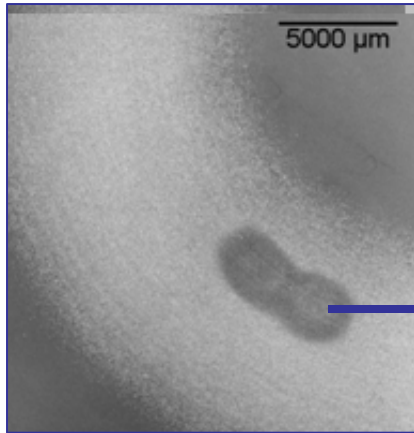
Pre RF Test



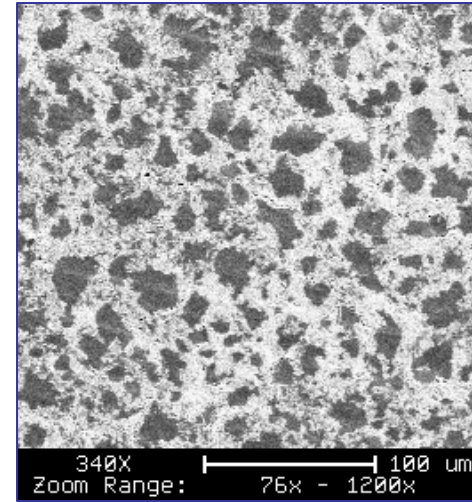
T = 110°C



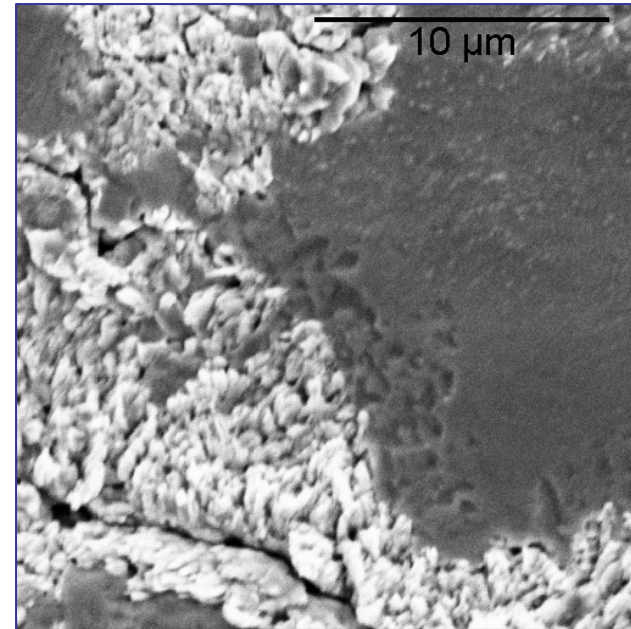
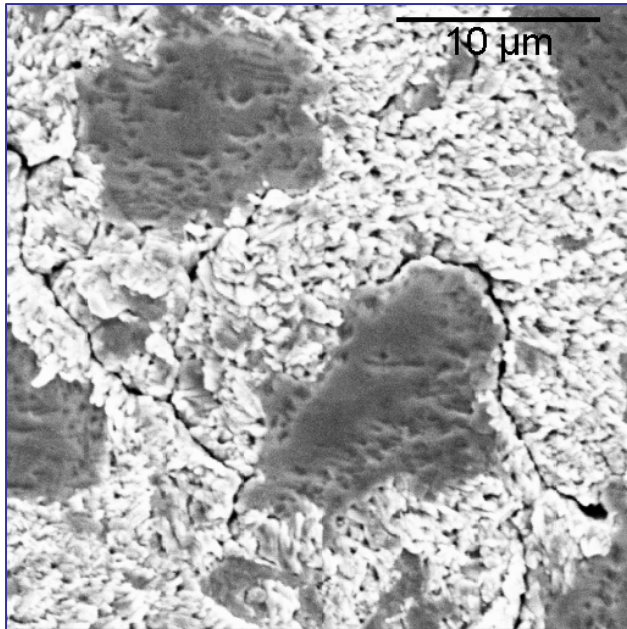
# E-Deposited Cu (KEK)



Inside "dark" patch



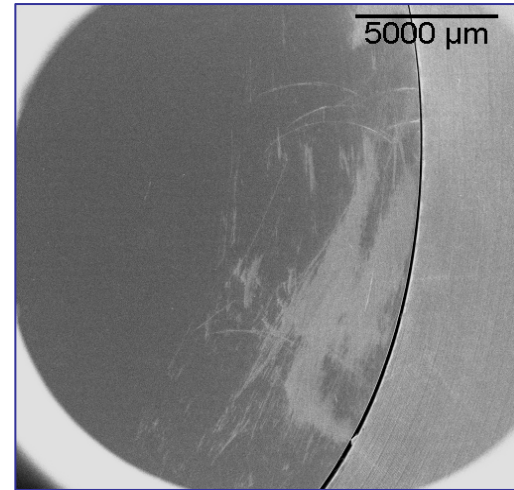
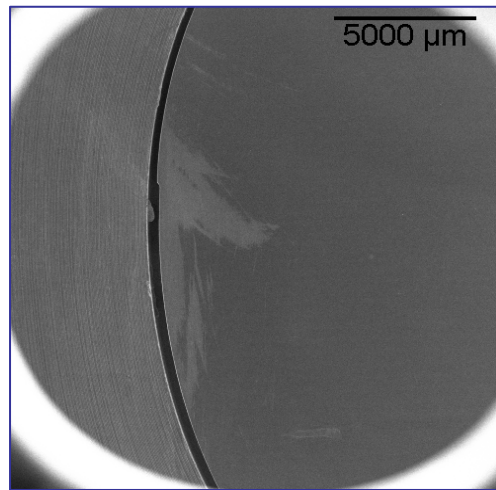
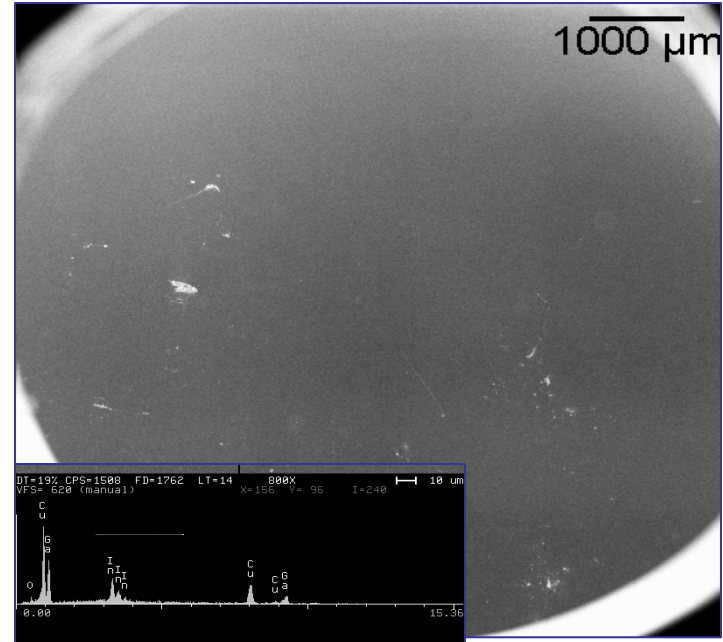
Outside "dark" patch



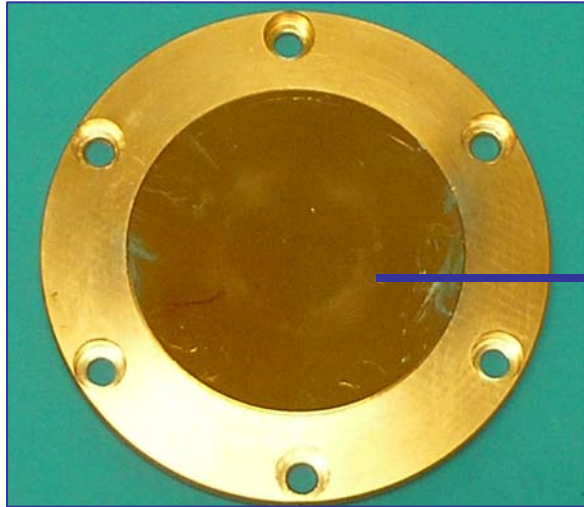
# Single Crystal Cu (KEK)



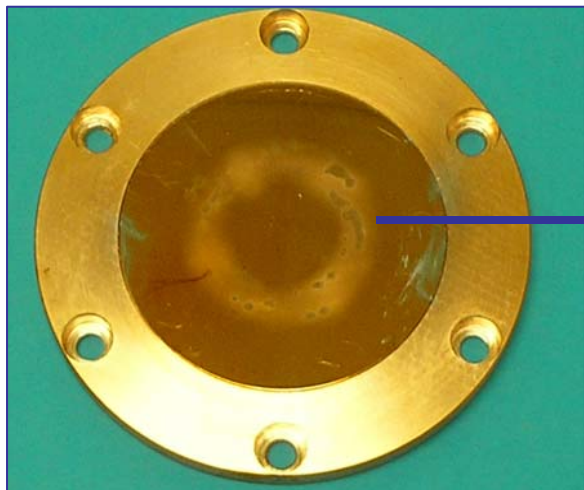
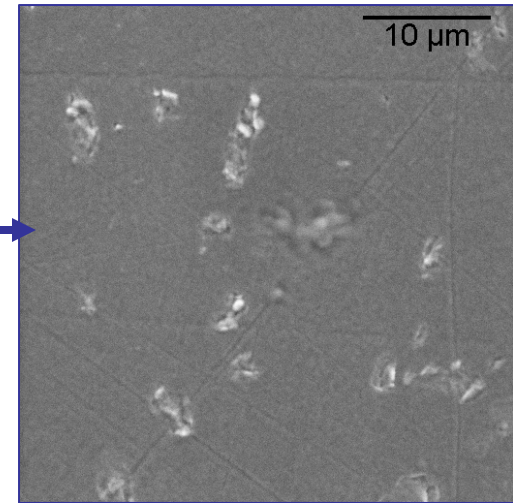
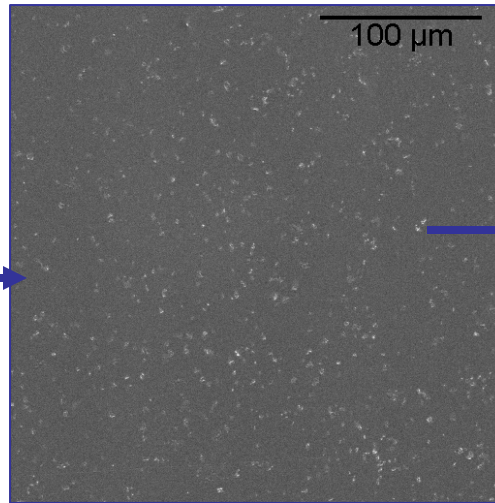
Pre RF Test



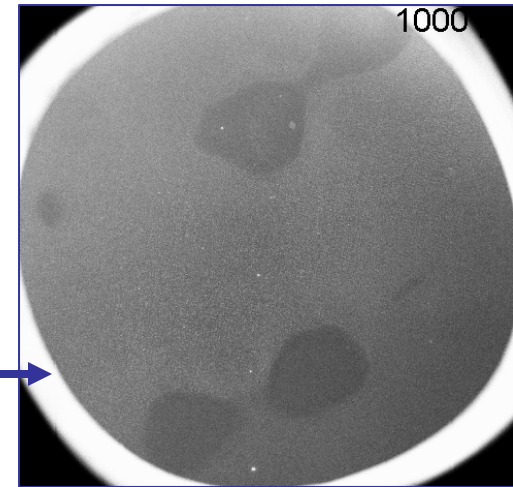
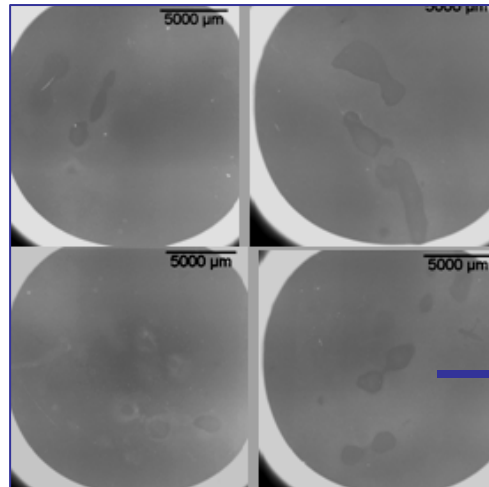
# Single Crystal Cu (KEK)



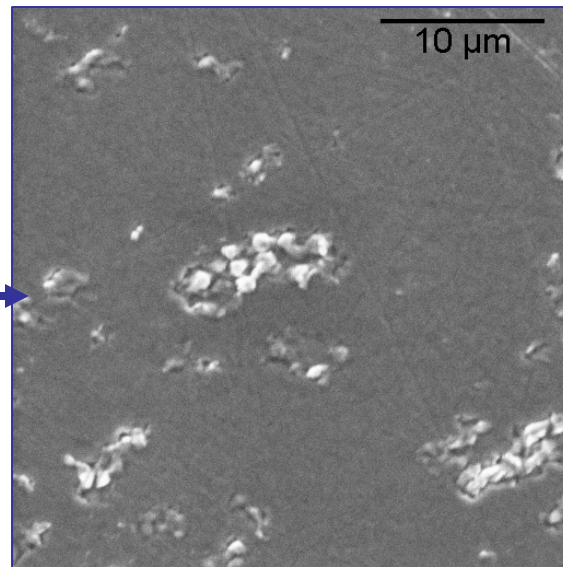
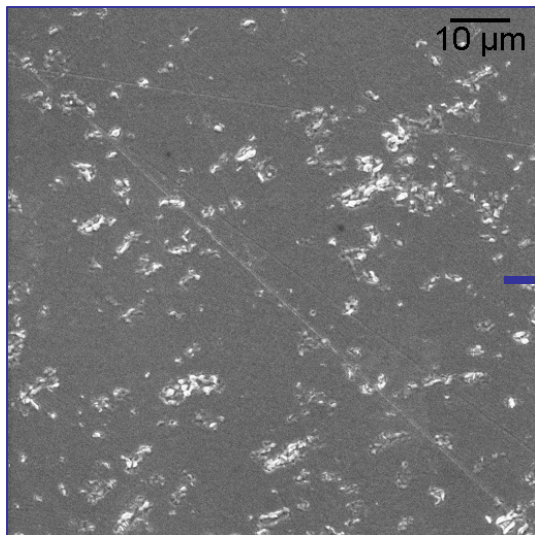
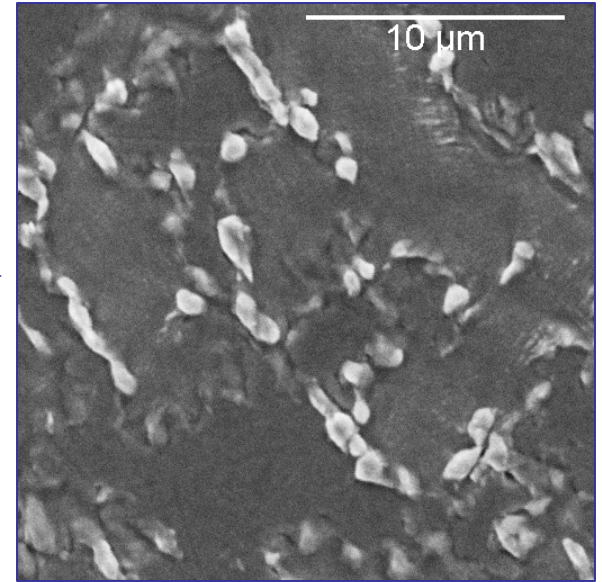
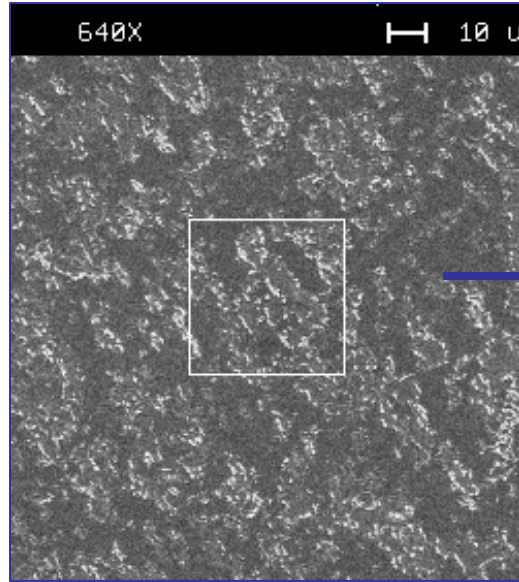
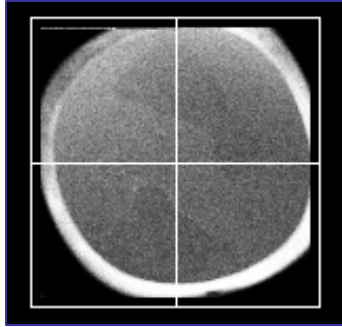
T = 70°C



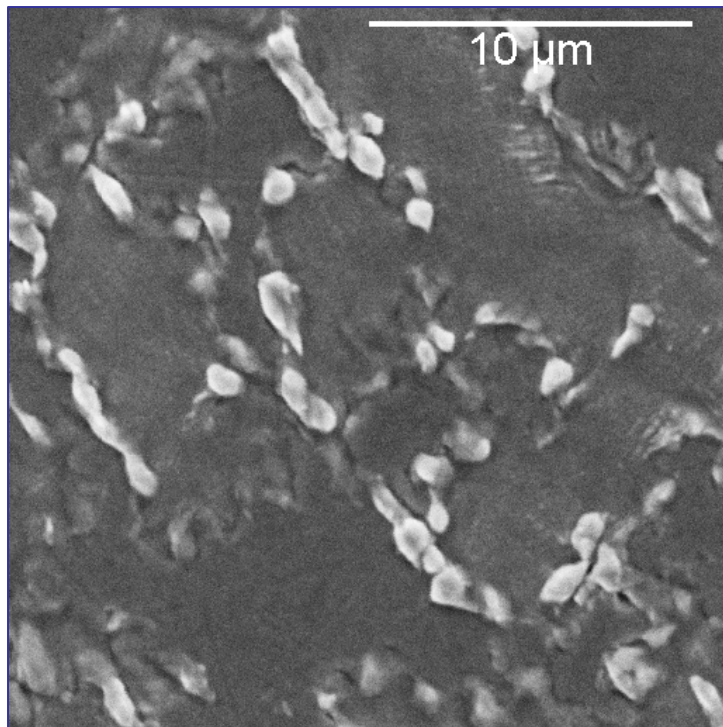
T = 110°C



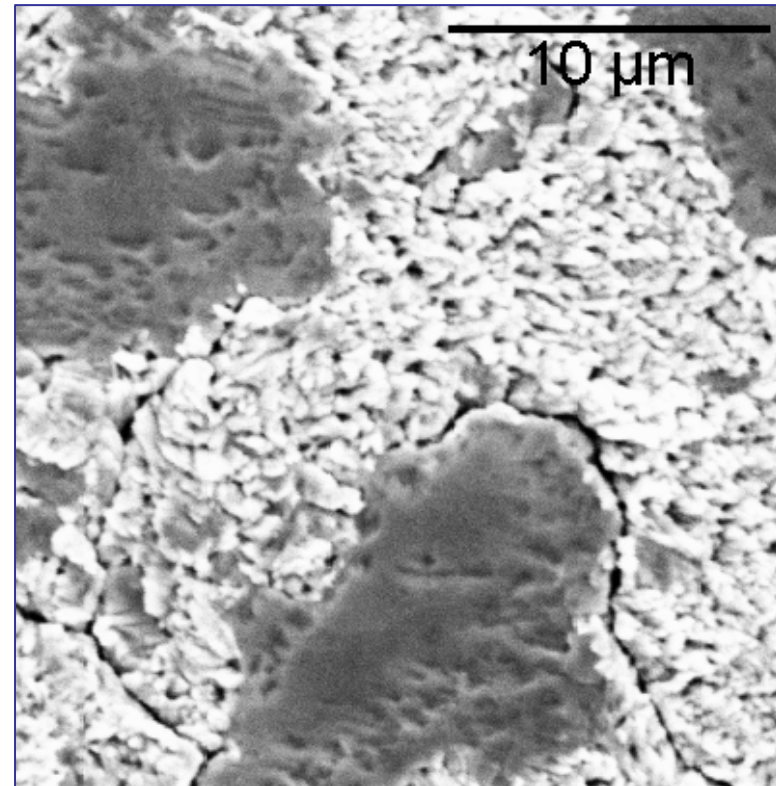
Single Crystal Cu (KEK)  
T = 110°C



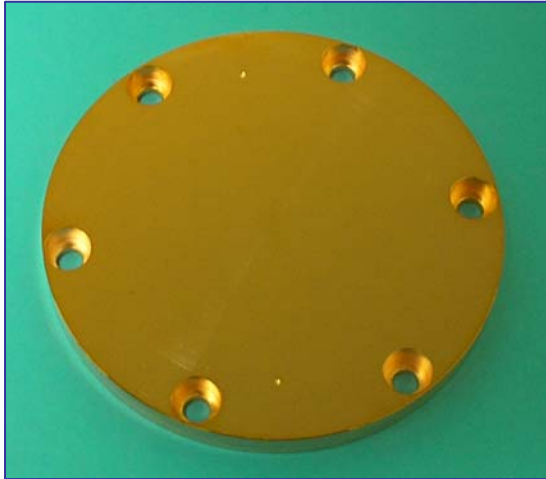
Single Crystal Cu (KEK)



Electro-deposited Cu (KEK)



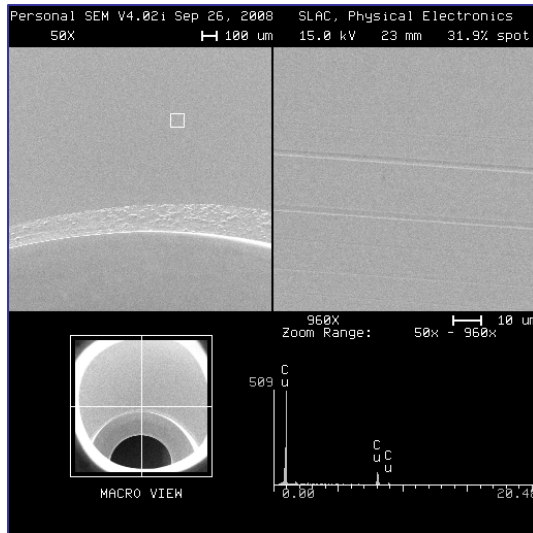
# HIP Copper (KEK)



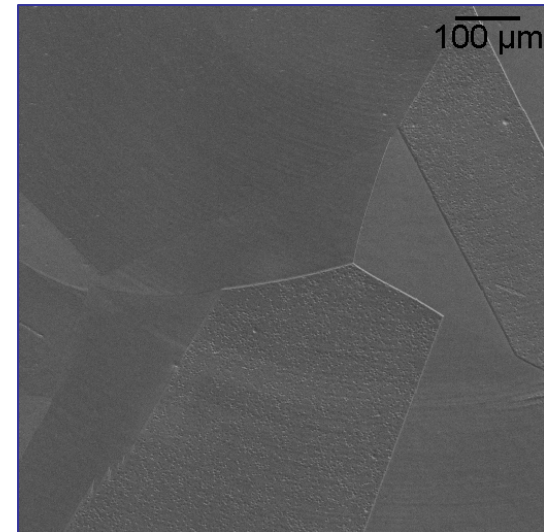
HIP1: No Etch



HIP2: Etched

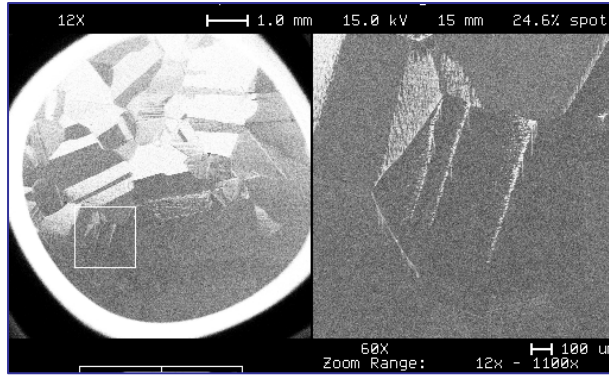
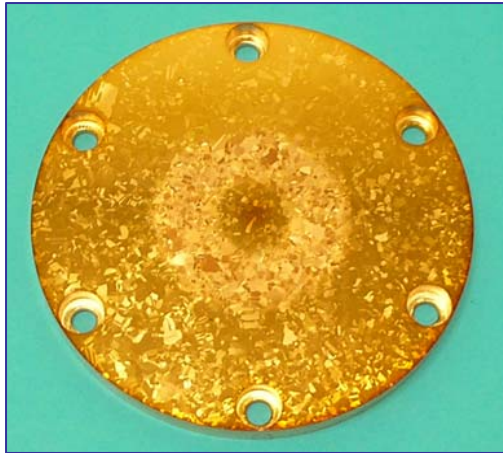


HIP1: Pre RF Testing

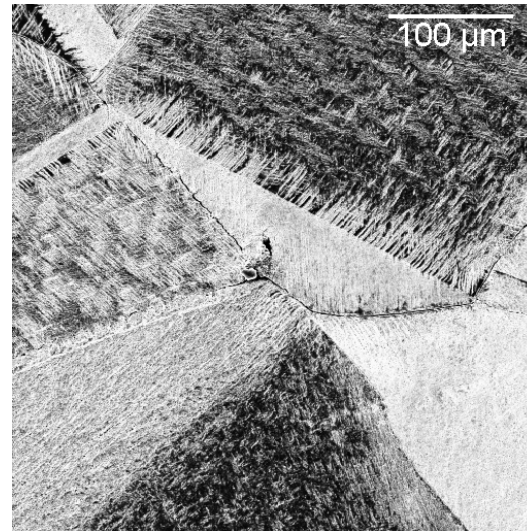
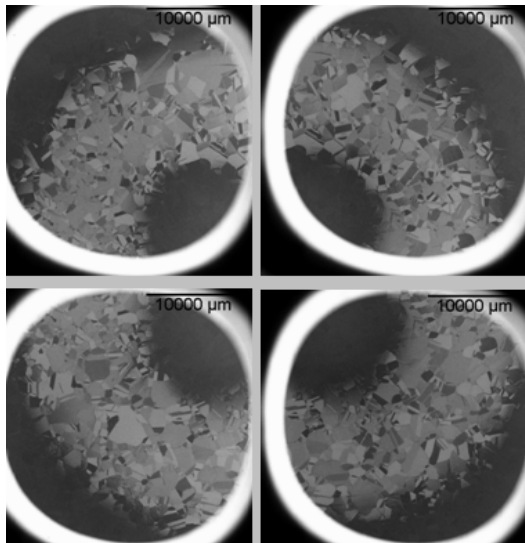
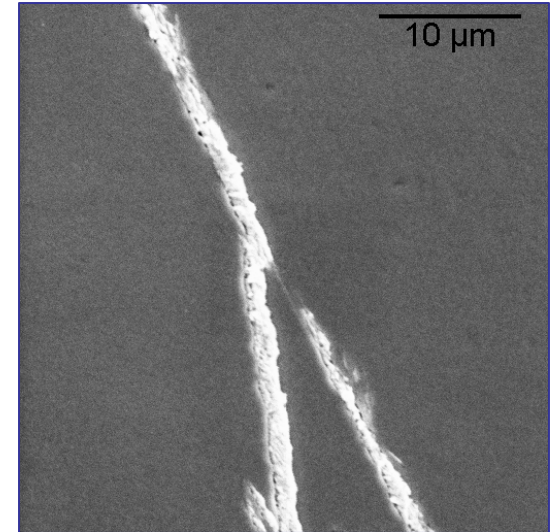


HIP2: Pre RF Testing

# HIP2 Copper (KEK): After RF Test T = 110°C

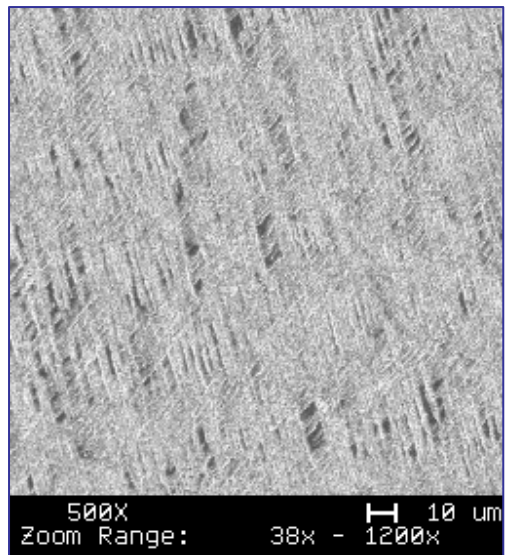
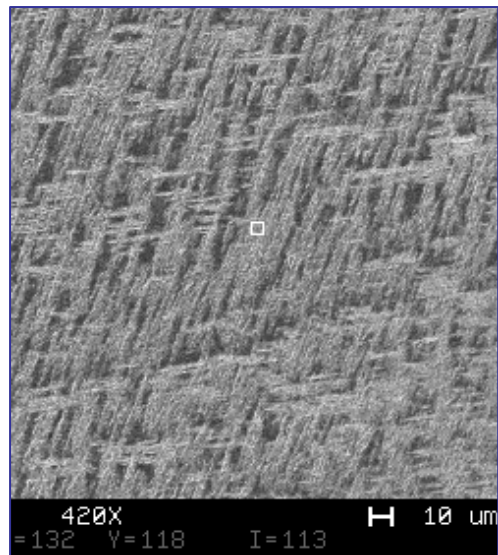
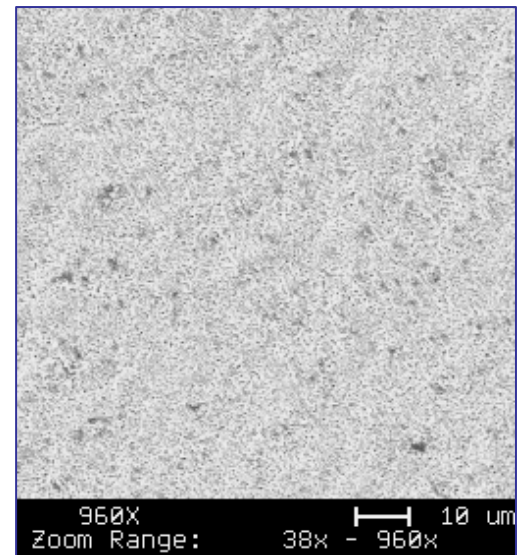
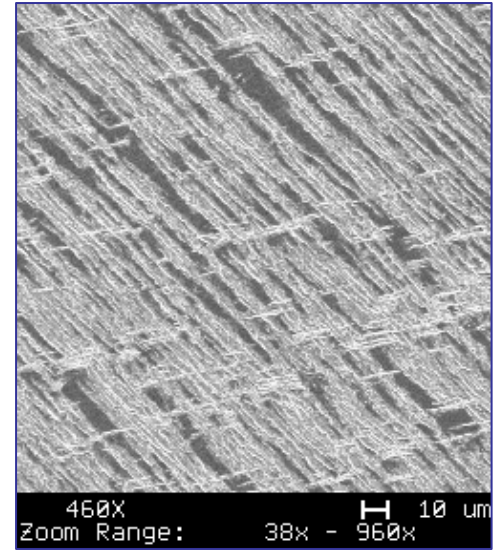
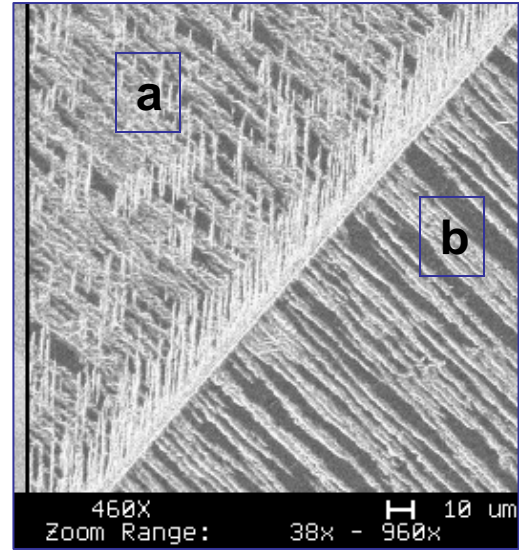
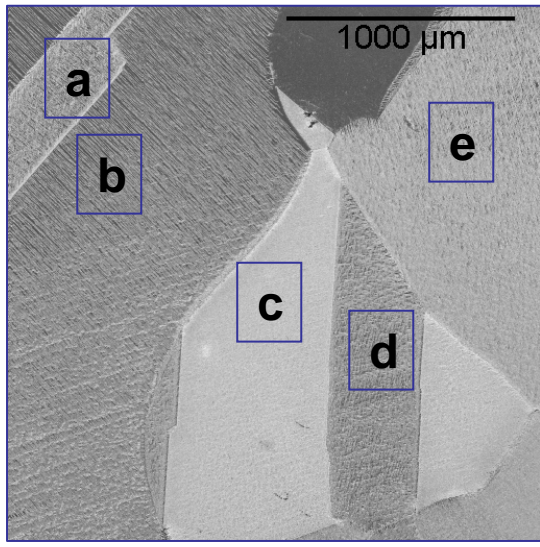


Near outer edge of pulse heating ring

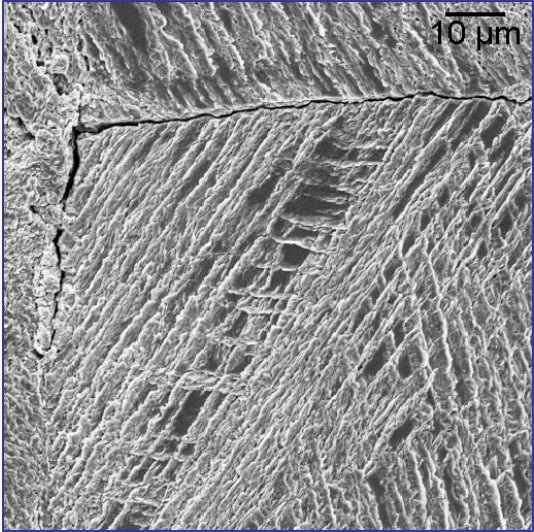
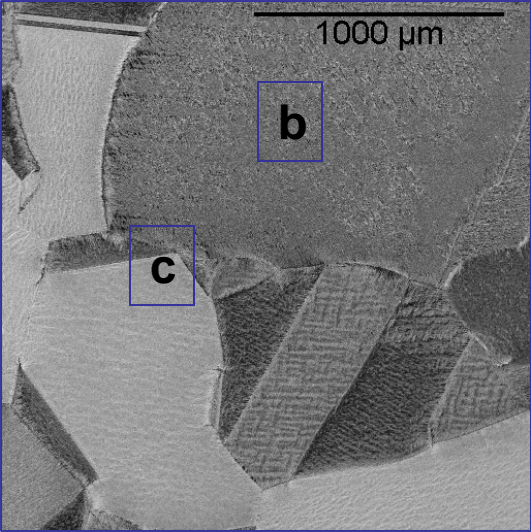




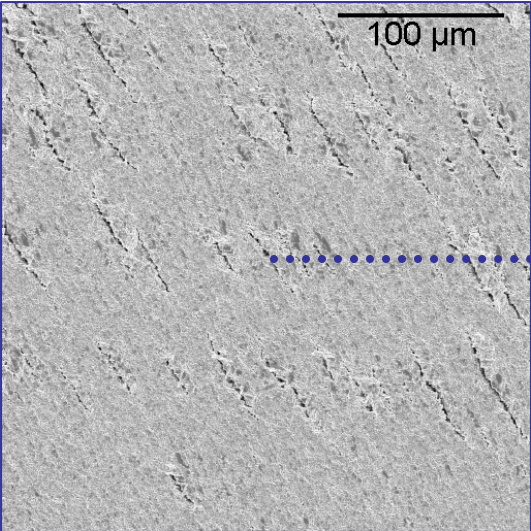
# HIP2 Copper (KEK)



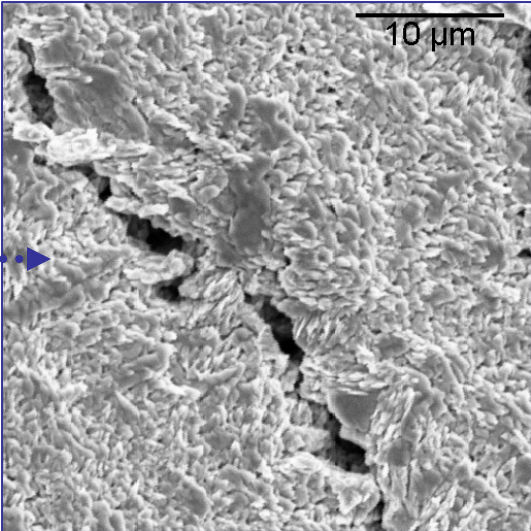
HIP2 Copper (KEK)



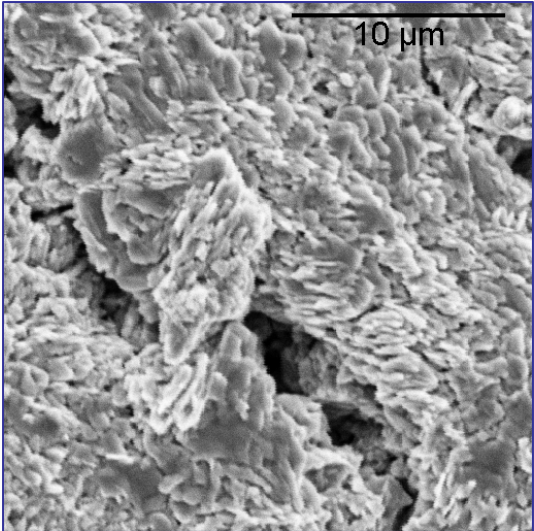
**c**



**b**

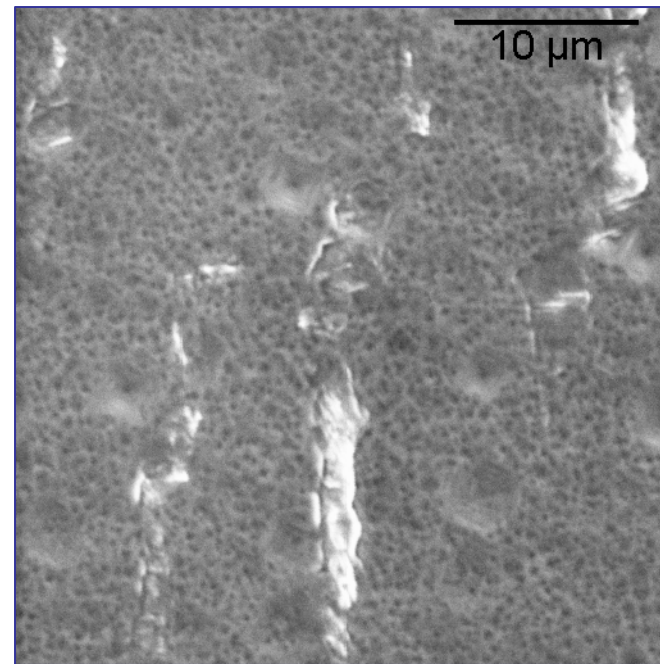
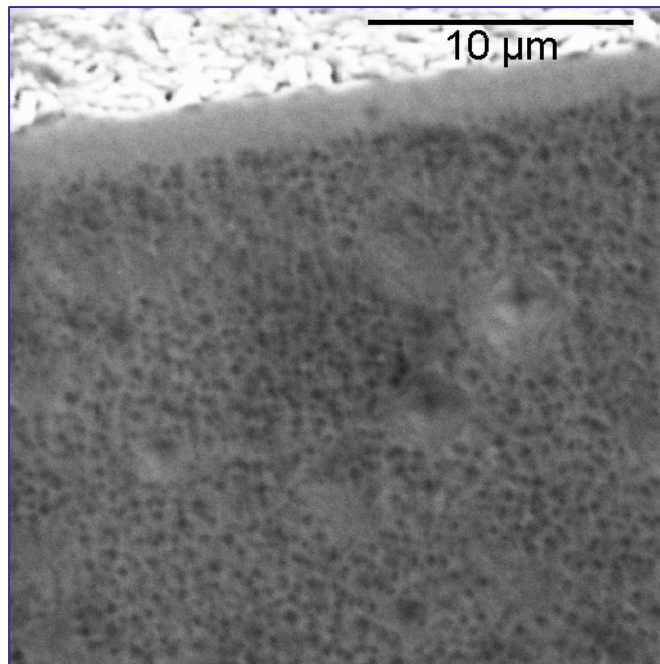


**b**

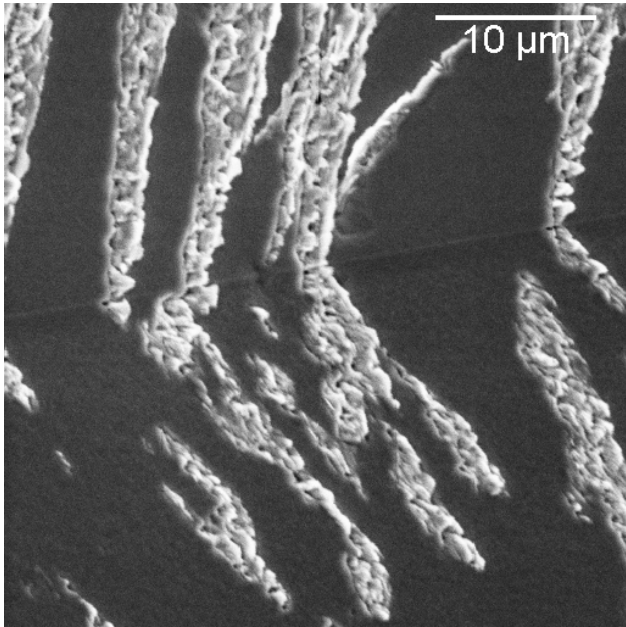
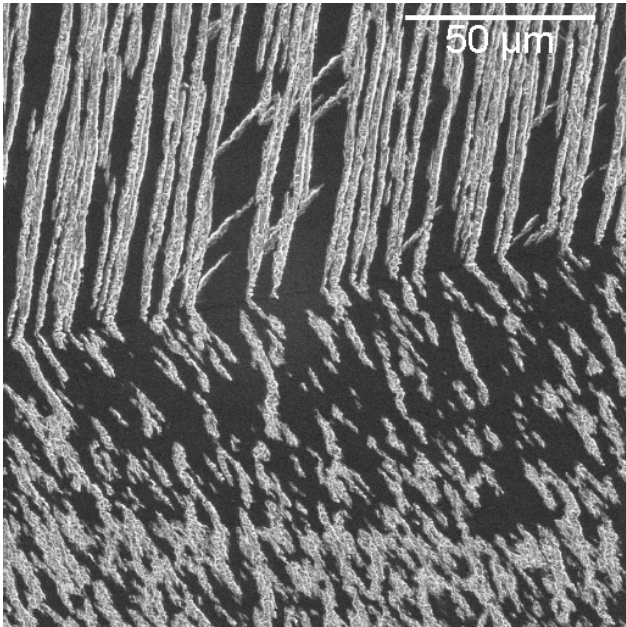
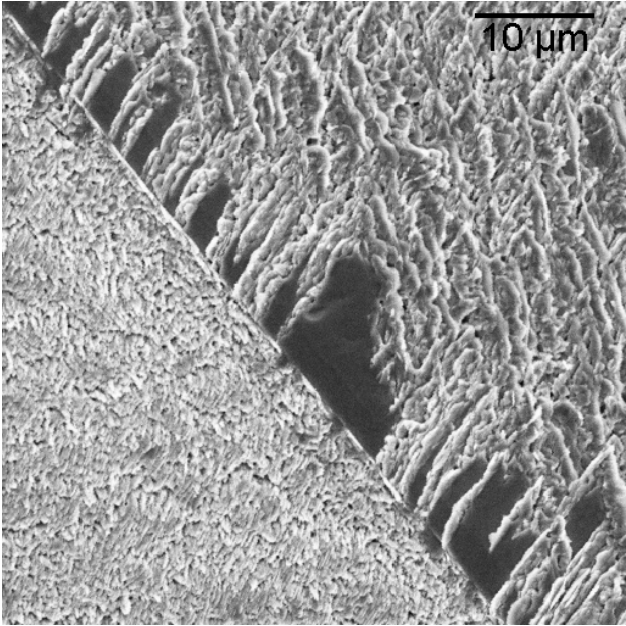
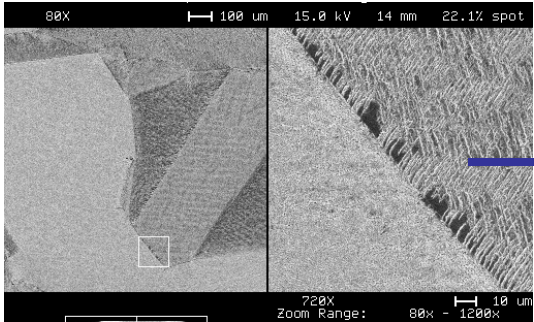


**b**

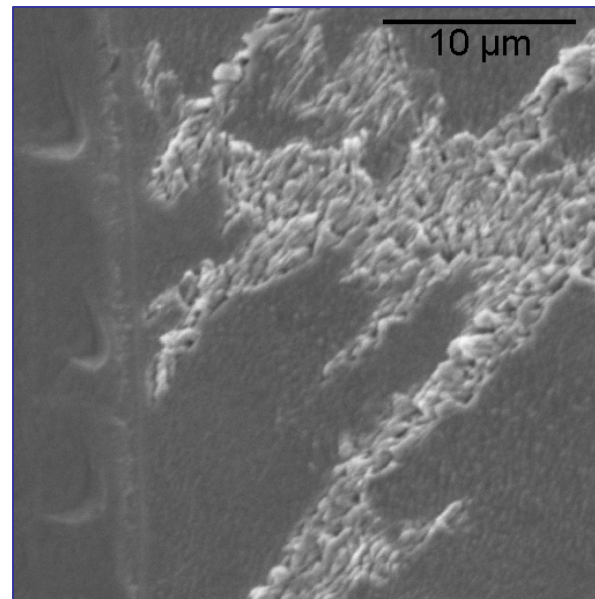
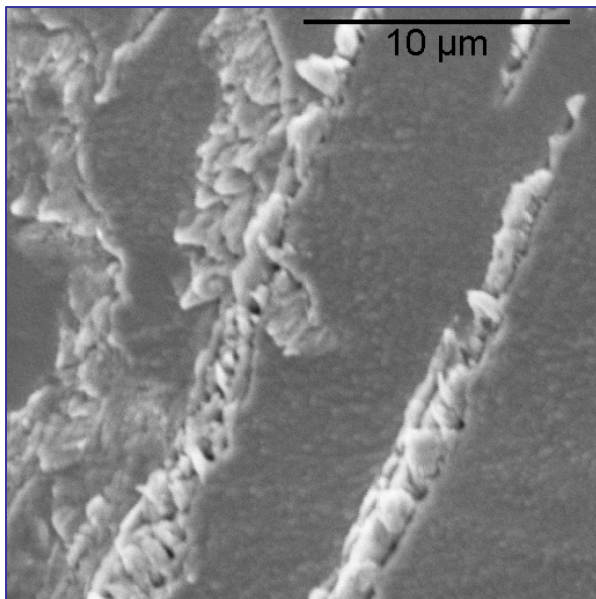
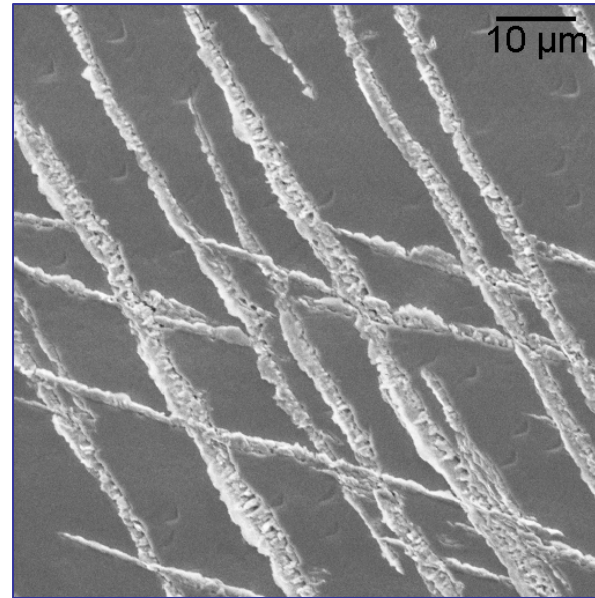
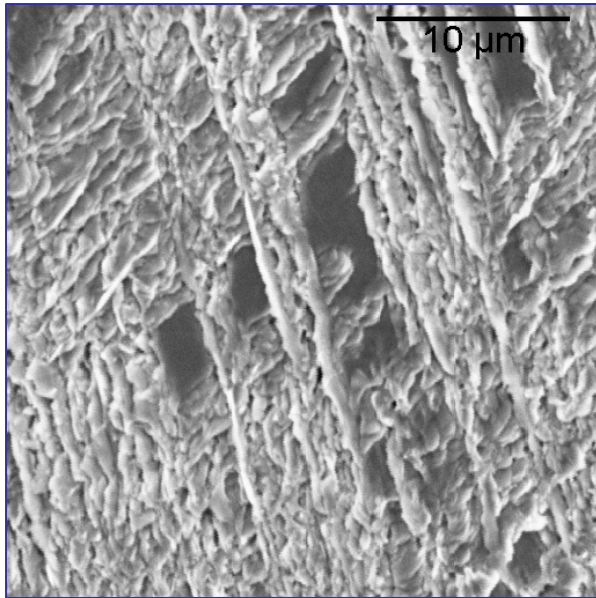
HIP2 Copper (KEK)



HIP2 Copper (KEK)



## HIP2 Copper (KEK): High Magnification SEM Images



CuCr\_102 (SLAC): This Sample Was Not Annealed

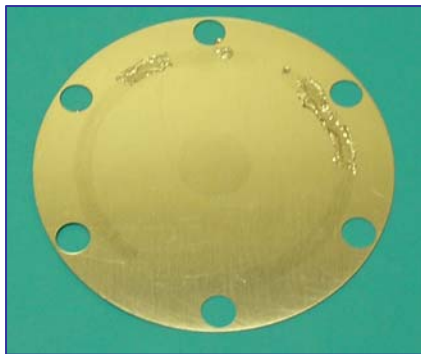


Before RF Testing



After RF Testing: T= 110°C

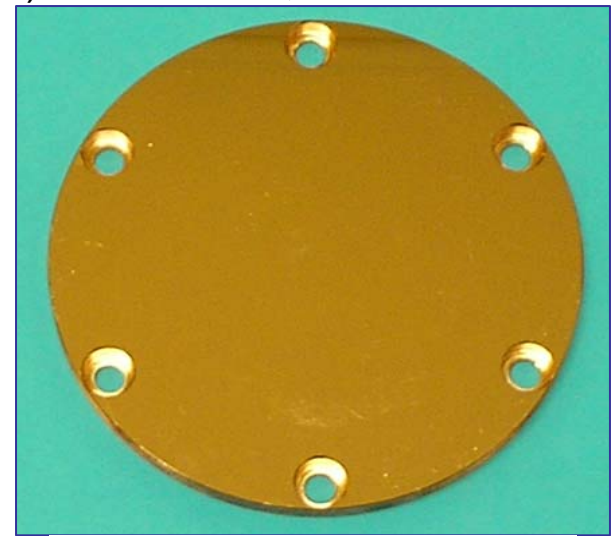
CuZr3-2 Cold Worked (CERN): Just Tested, No SEM Data



Spacer



Before RF Testing

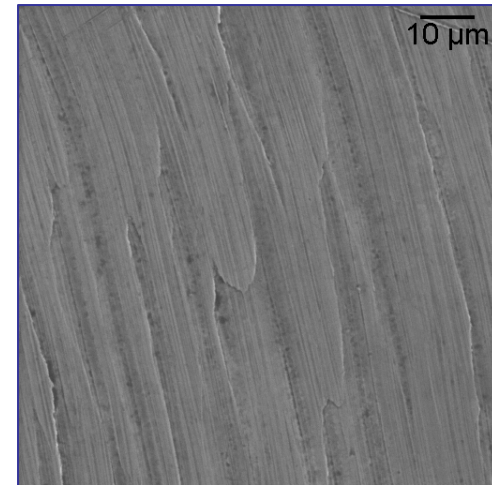


After RF Testing: T= 110°C

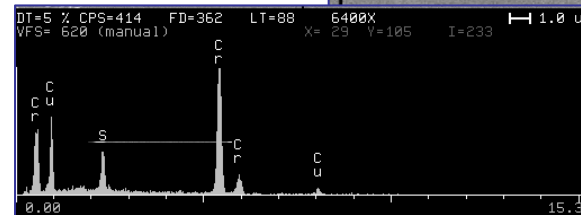
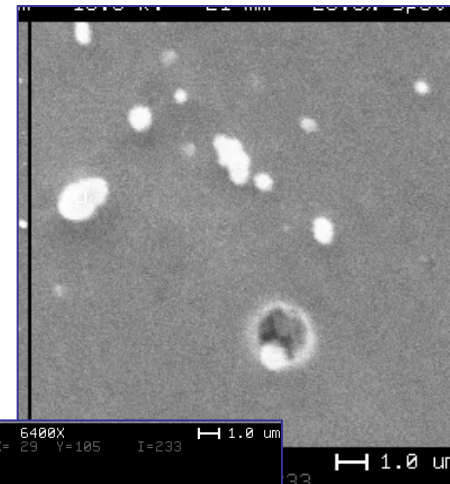
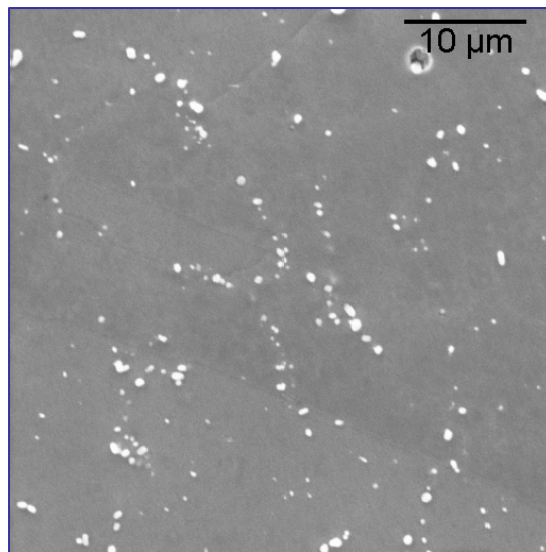
# CuCr\_102 (SLAC): Before RF Testing



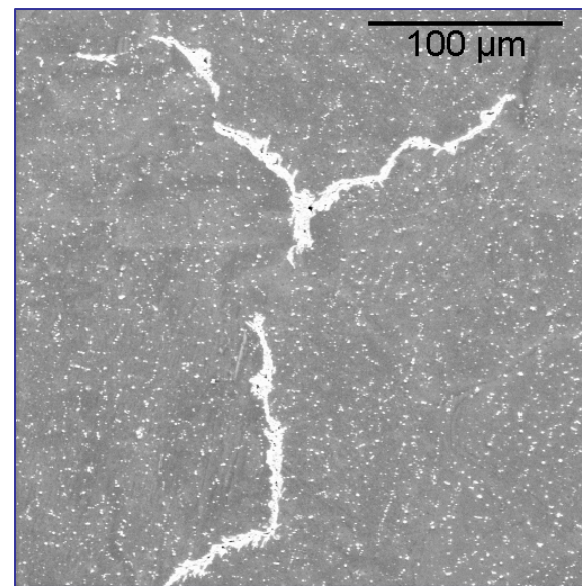
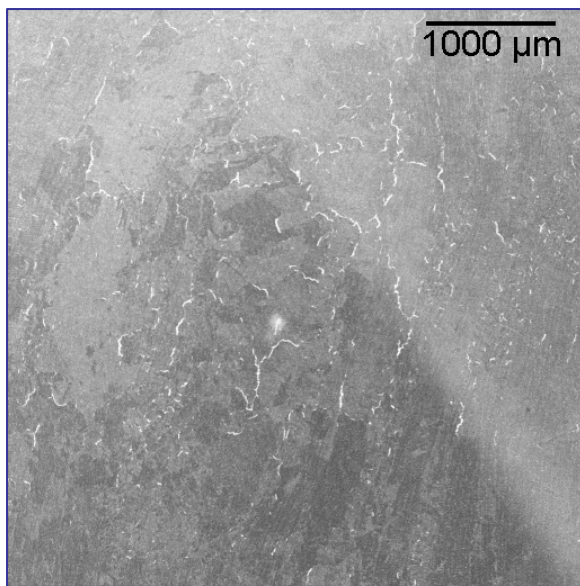
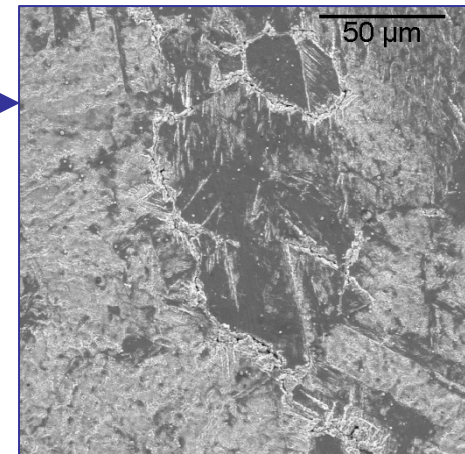
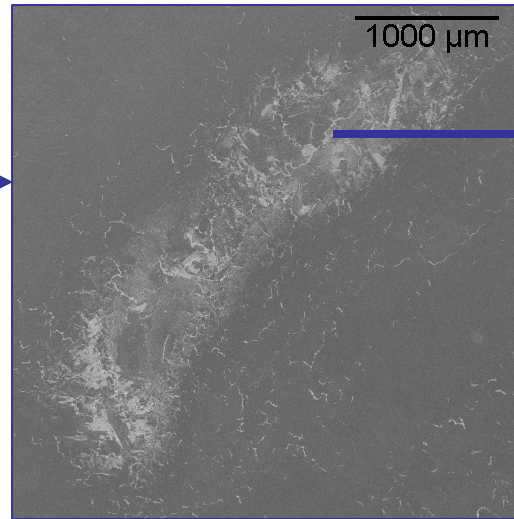
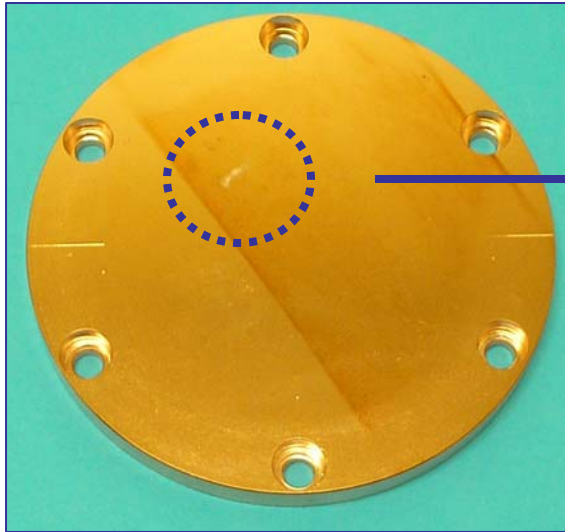
Before Etch



After Etch



CuCr\_102 (SLAC): After RF Test (T = 110°C)



Outside surface damaged region shown above





Pre RFTesting



T = 110°C

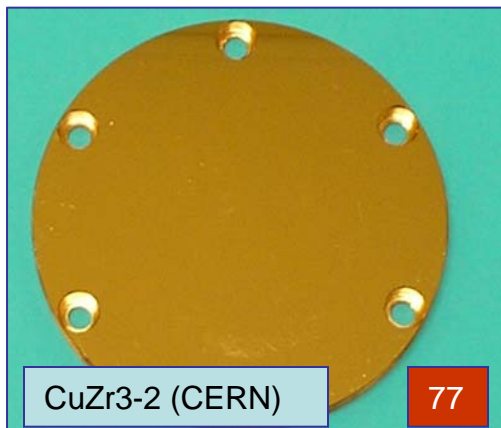
Cu\_101 (SLAC): Recently Tested  
No SEM Data



CERN Cu1-2

Pulse Heating Samples RF  
Tested

May 2008 – September 2008



Hardness Test Value

Pulse Heating Samples RF  
Tested

May 2008 – September 2008

Hardness Test Value

