



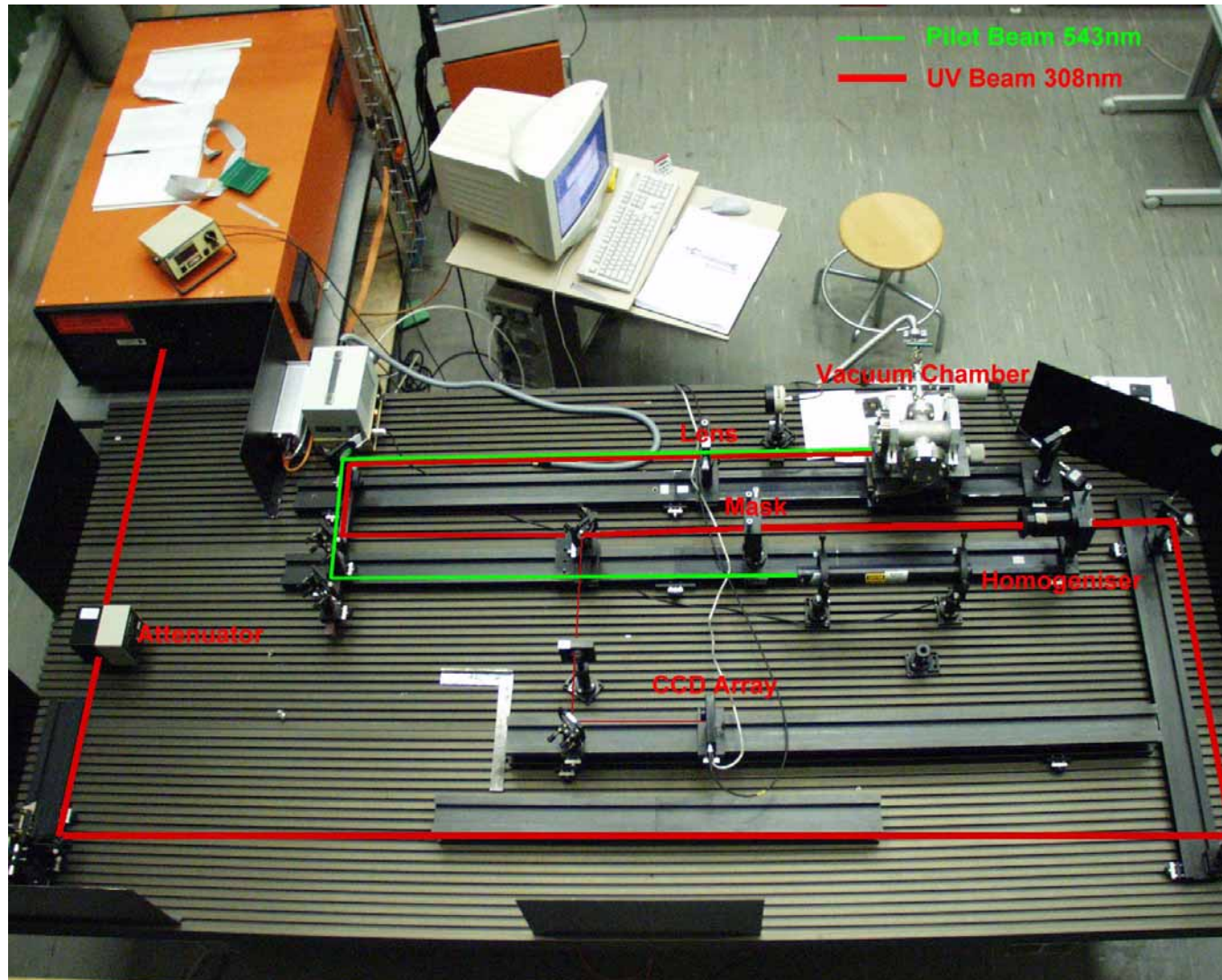
Laser pulsed heating – Fatigue tests



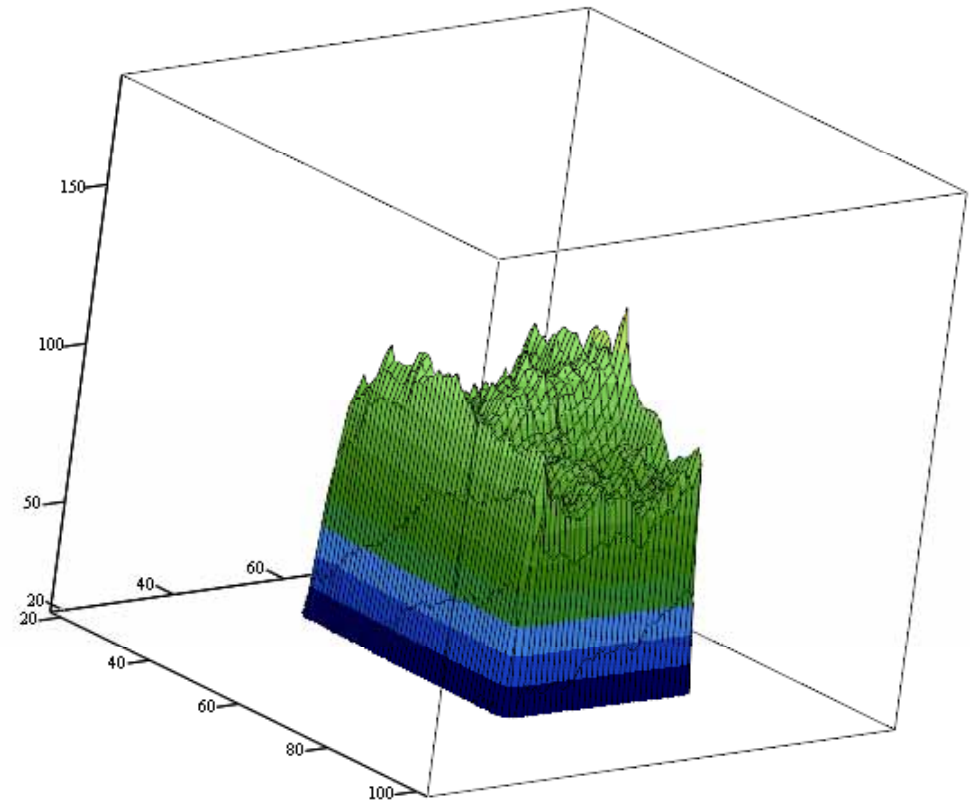
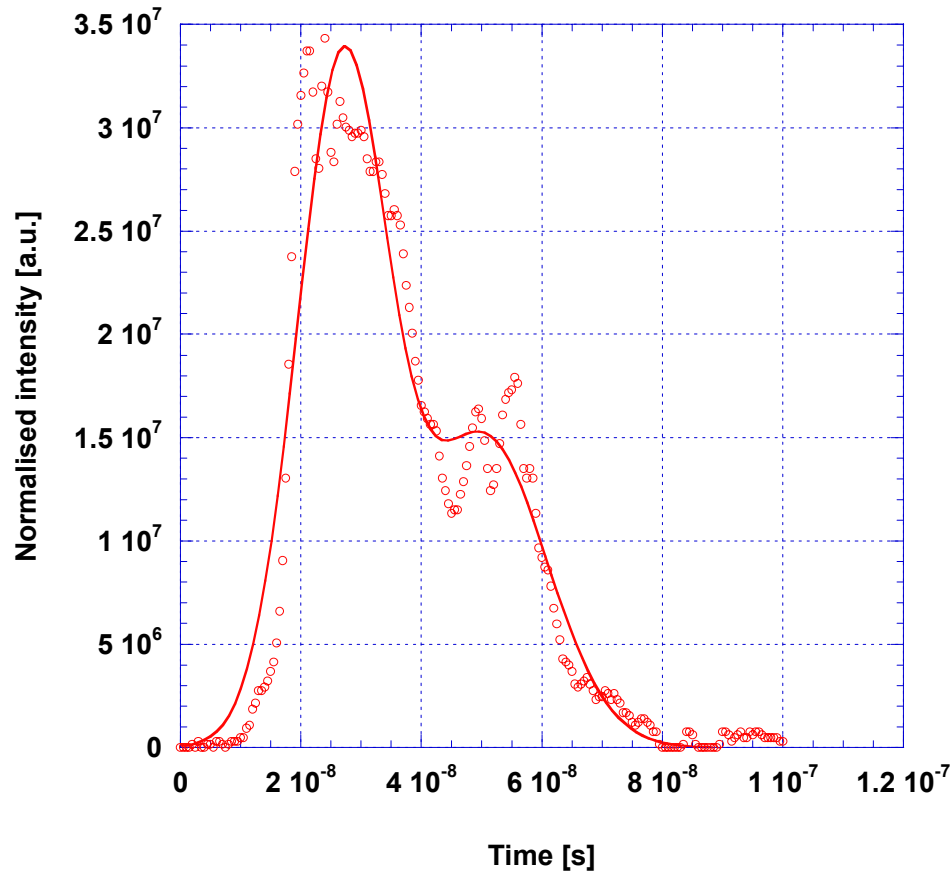
Tests on Cu and Cu/Zr

- Already presented: Temperature simulation for pulsed laser heating, fatigue model (Kovalenko), Surface treatment on Cu and W
- Thermal cycles on Cu and Cu/Zr (C15000, 0.15%Zr) surfaces with different energy densities (different ΔT) increasing the number of cycles
- Observation of surface damage with electron microscope, comparing Cu with Cu/Zr
- Quantification of surface degradation by roughness measurement, prediction possibilities
- Conclusions

Laser pulsed heating – Fatigue tests

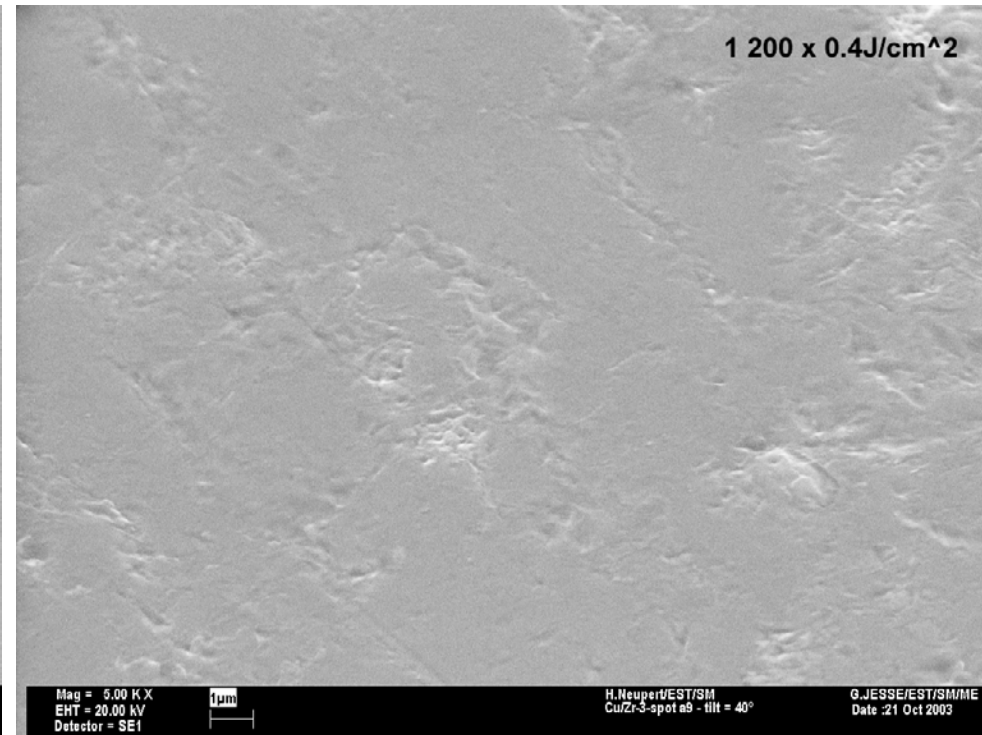
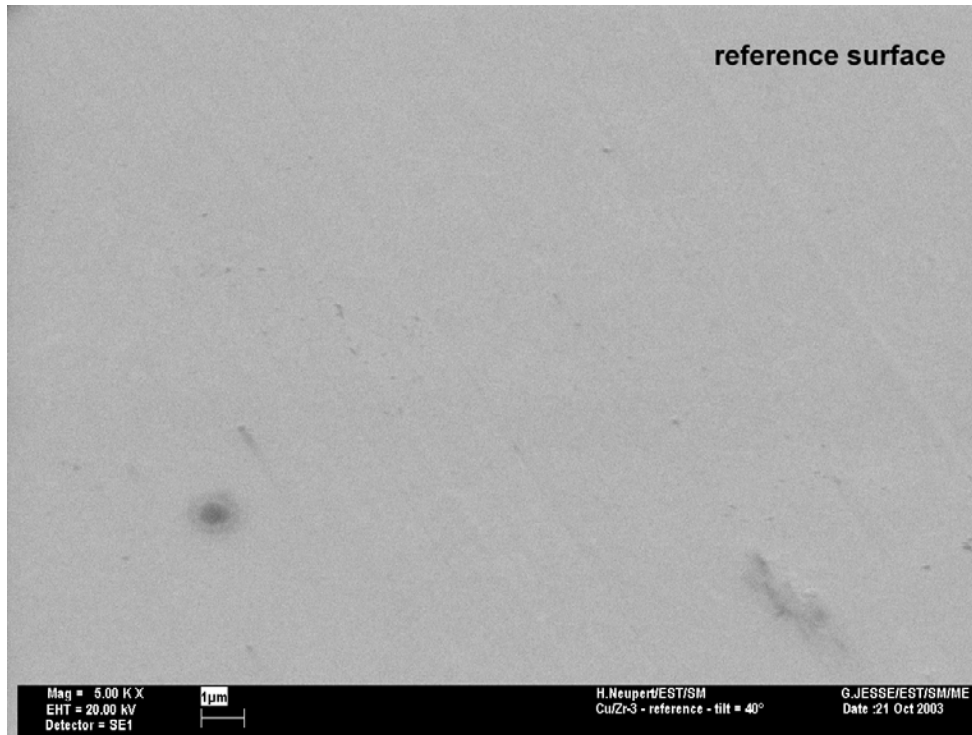


Excimer laser 308 nm



Time profile and spatial energy distribution of the laser beam

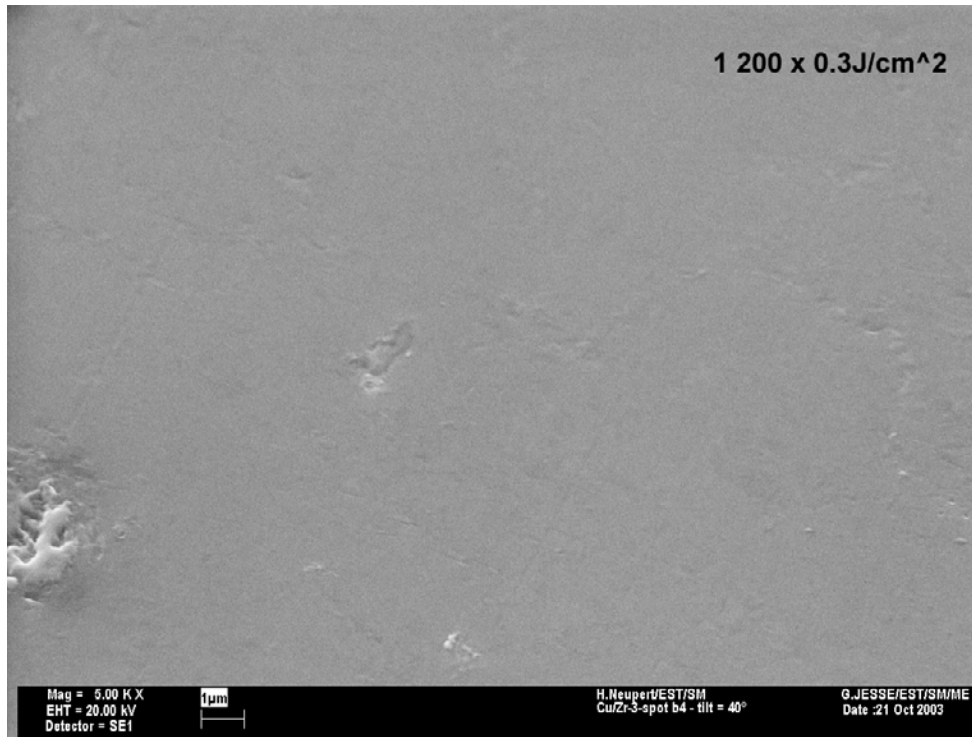
Different ΔT on Cu/Zr



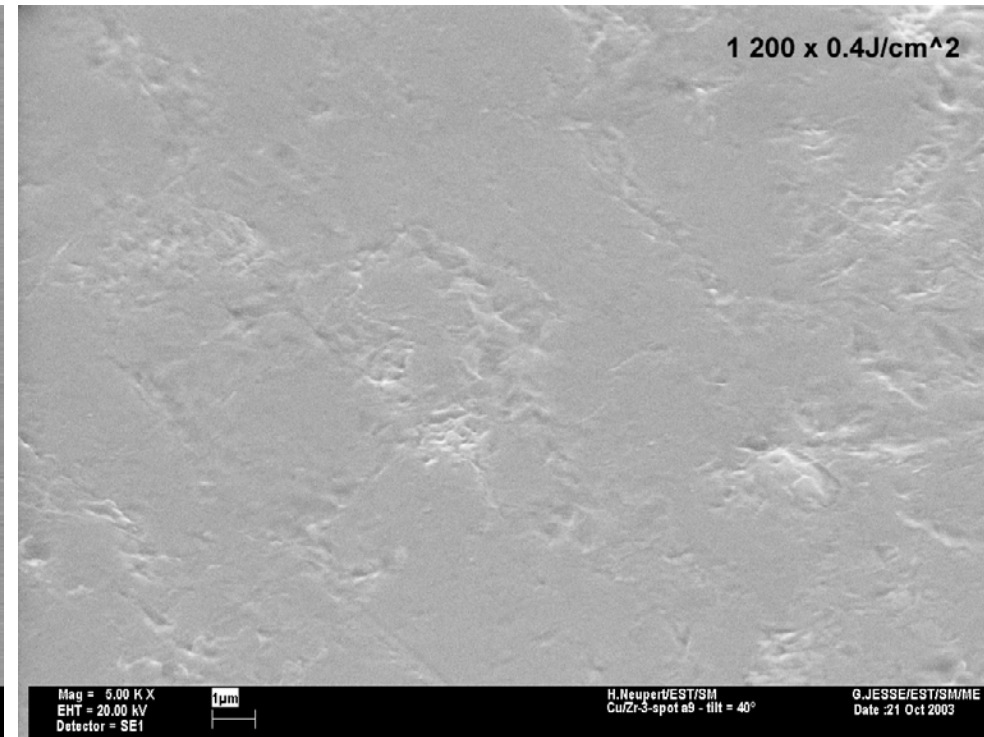
As received

After 1200 shots, $\Delta T = 240K$

Different ΔT on Cu/Zr

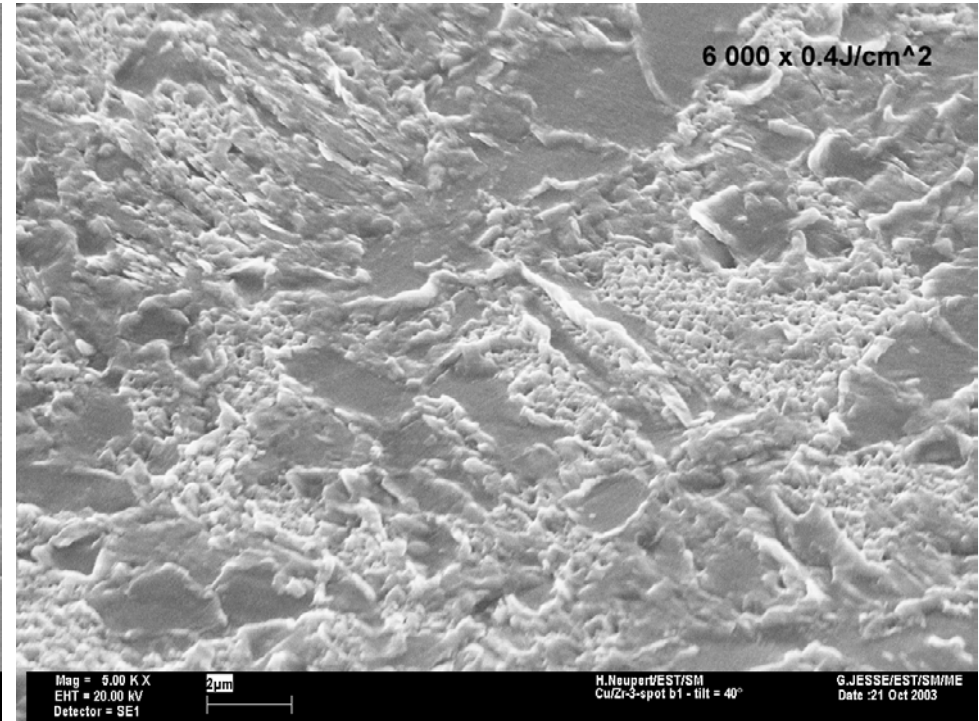
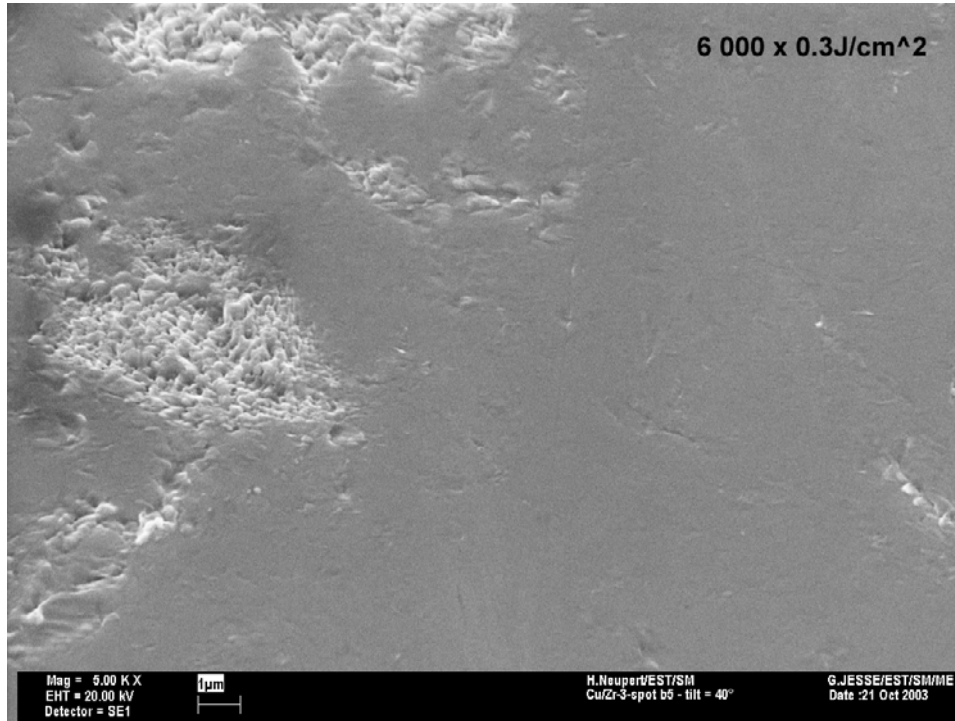


After 1200 shots, $\Delta T = 180\text{K}$



After 1200 shots, $\Delta T = 240\text{K}$

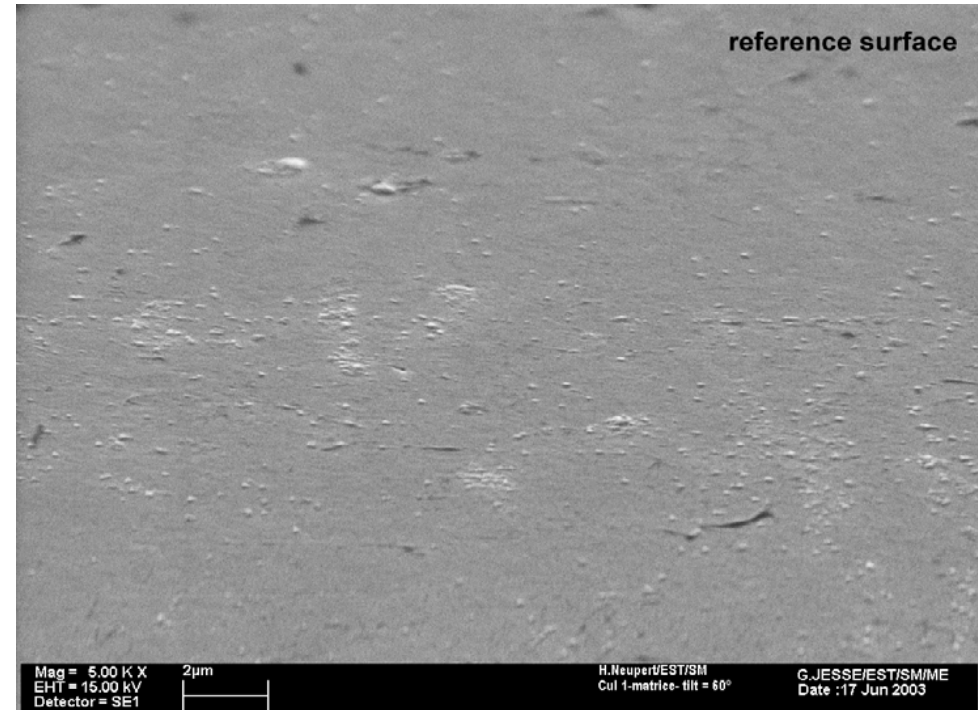
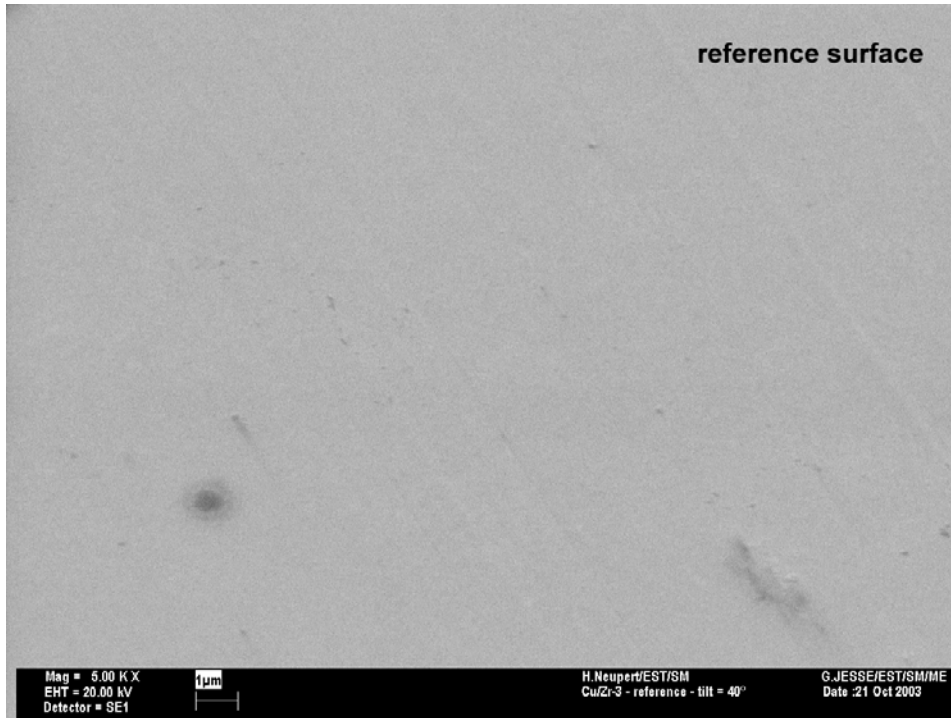
Different ΔT on Cu/Zr



After 6000 shots, $\Delta T = 180\text{K}$

After 6000 shots, $\Delta T = 240\text{K}$

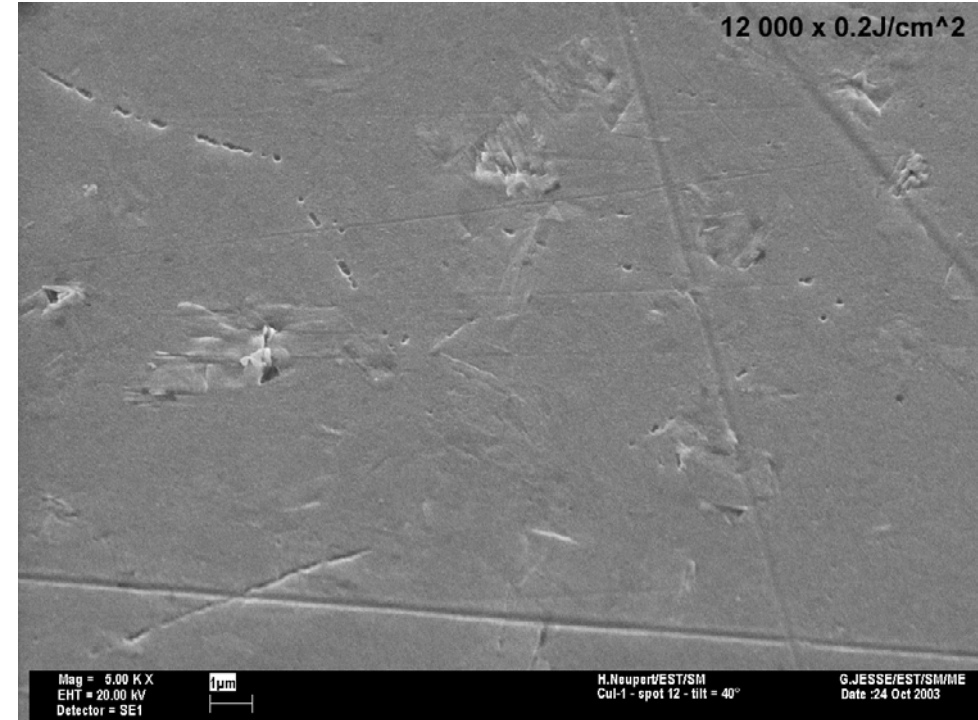
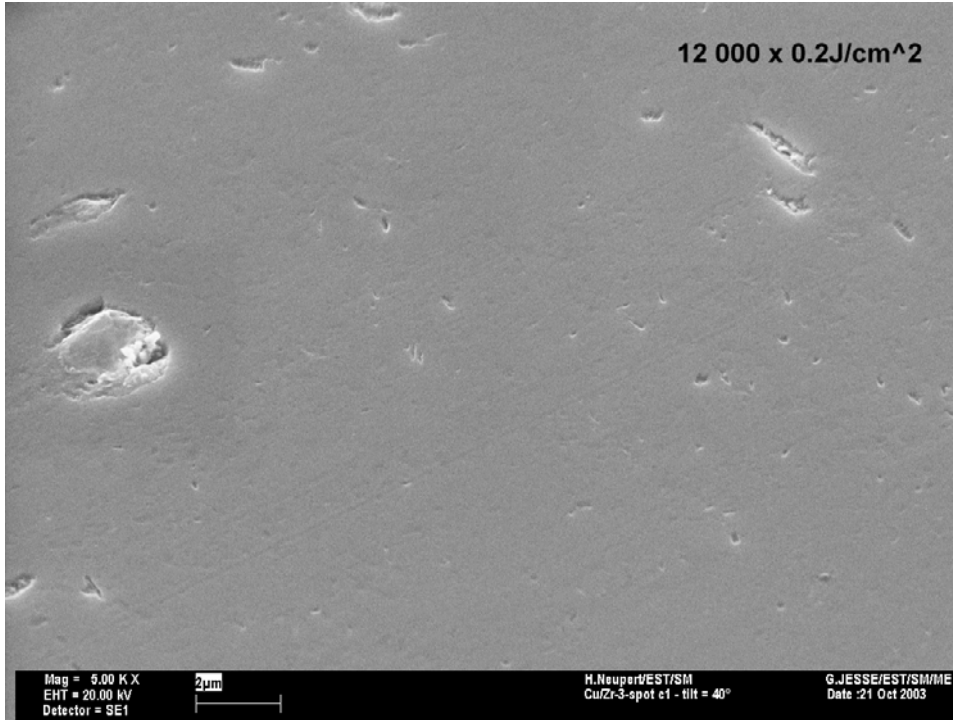
Comparing Cu/Zr with Cu, Reference Surfaces



Cu/Zr reference surface

Cu reference surface

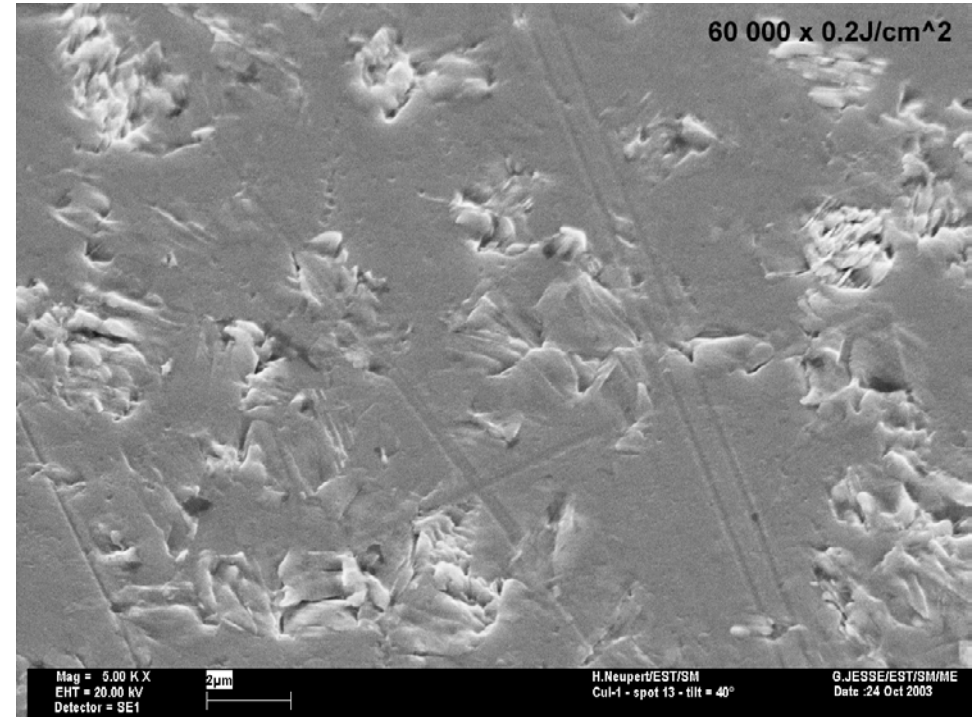
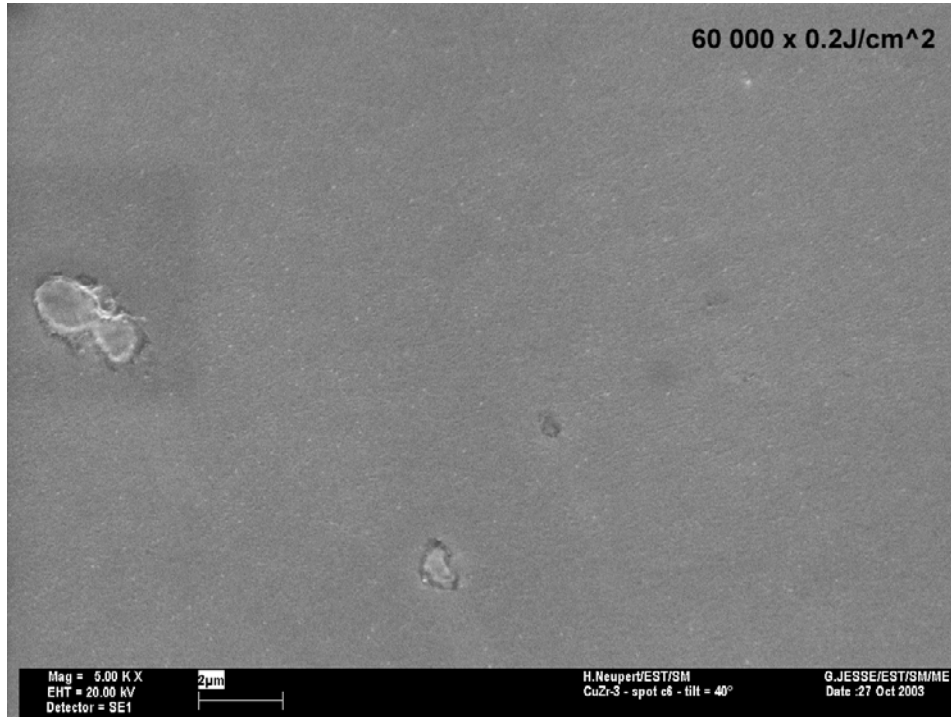
Comparing Cu/Zr with Cu at $\Delta T = 120\text{K}$



Cu/Zr 12000 shots

Cu 12000 shots

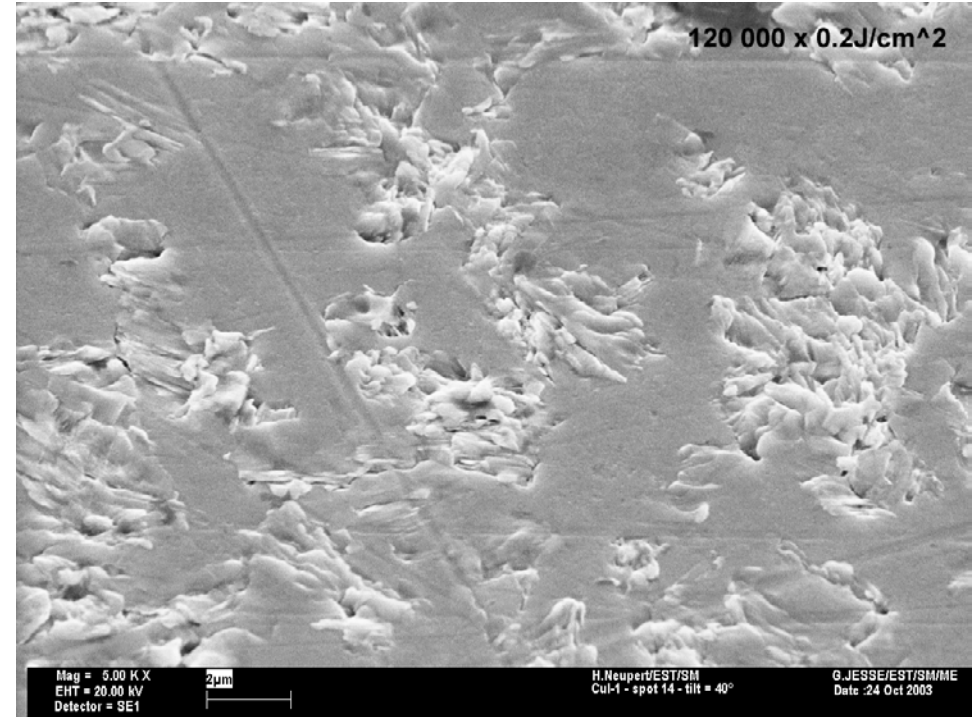
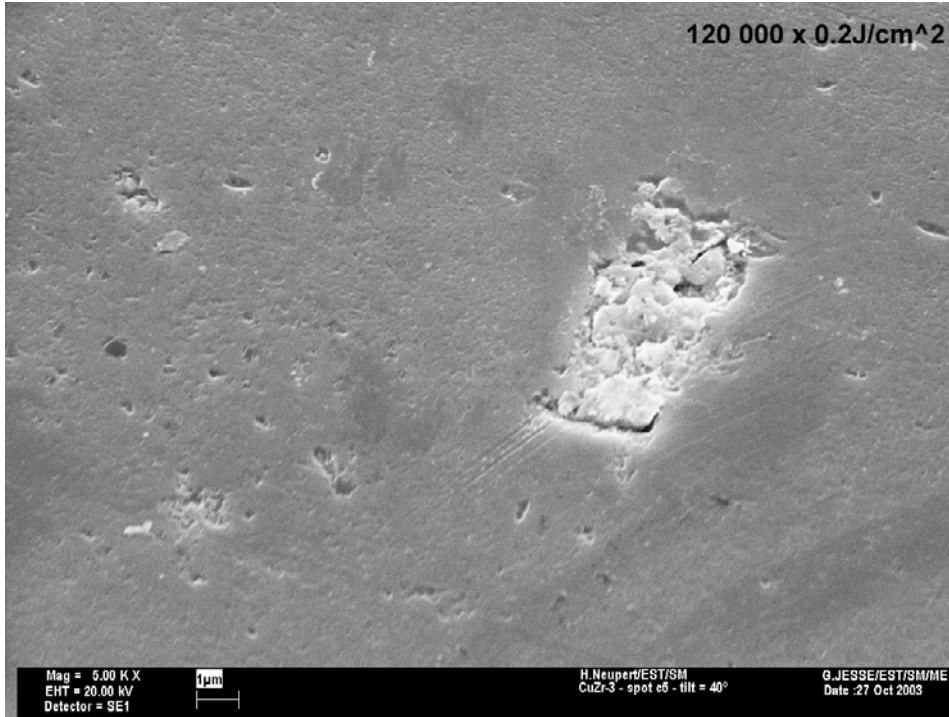
Comparing Cu/Zr with Cu at $\Delta T = 120\text{K}$



Cu/Zr 60000 shots

Cu 60000 shots

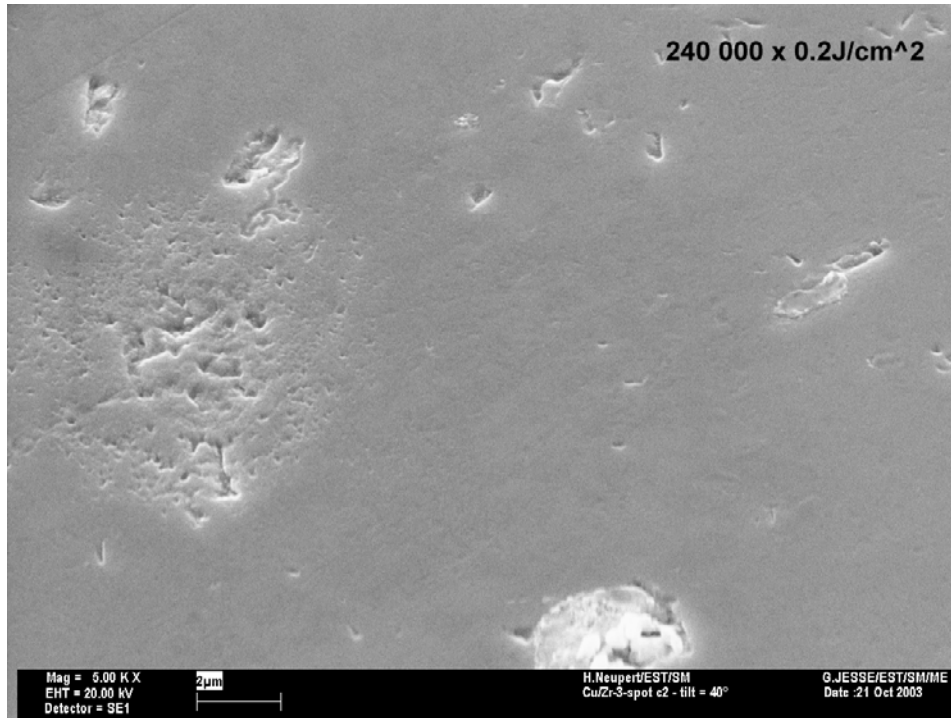
Comparing Cu/Zr with Cu at $\Delta T = 120\text{K}$



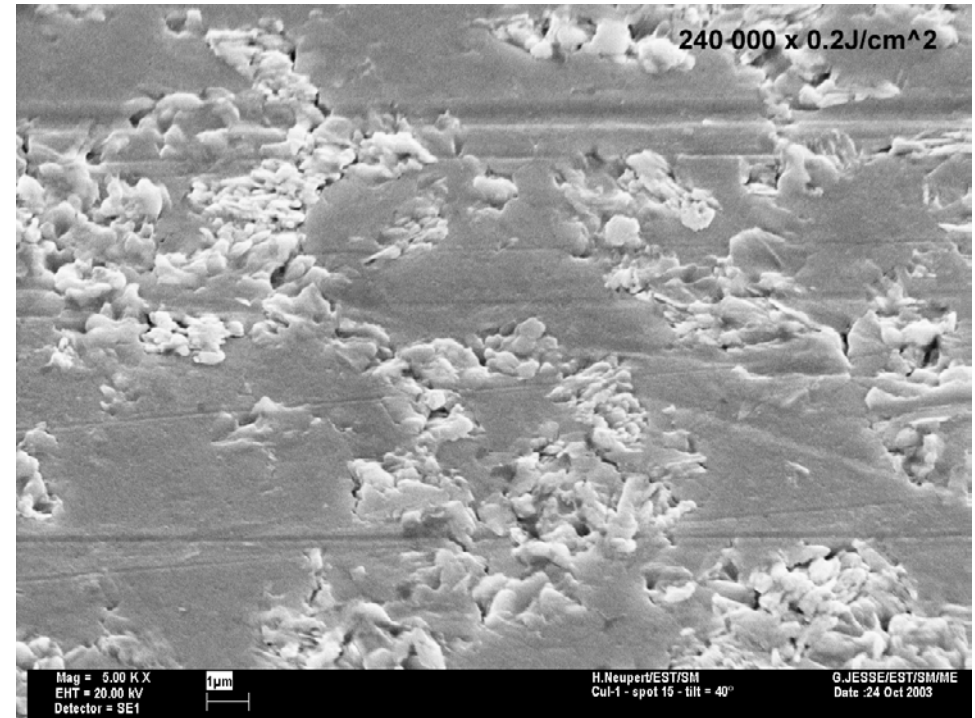
Cu/Zr 120000 shots

Cu 120000 shots

Comparing Cu/Zr with Cu at $\Delta T = 120\text{K}$

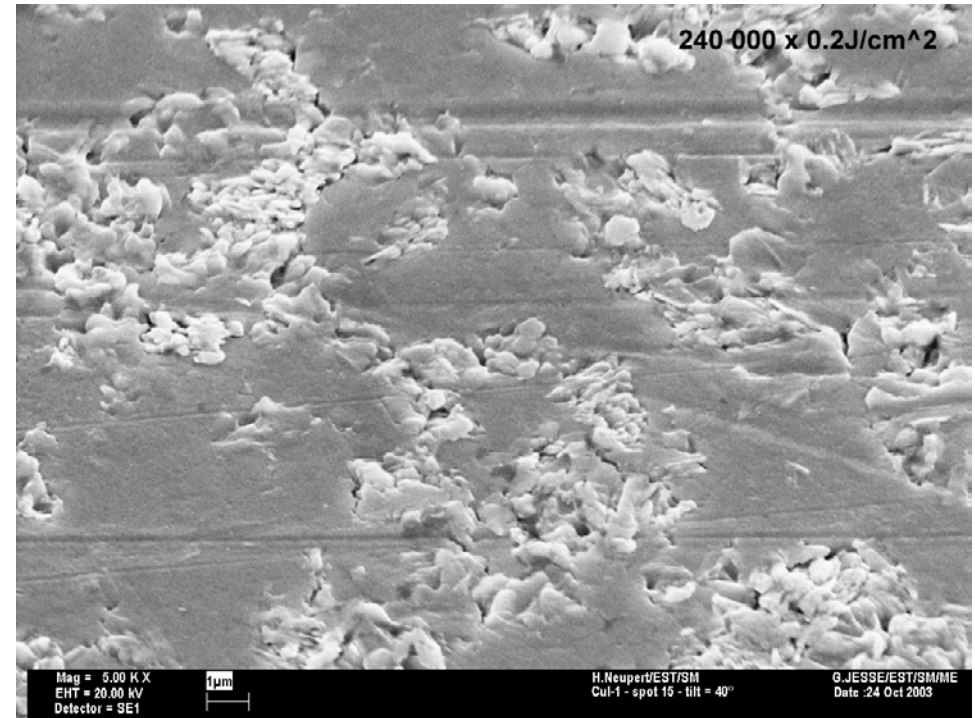
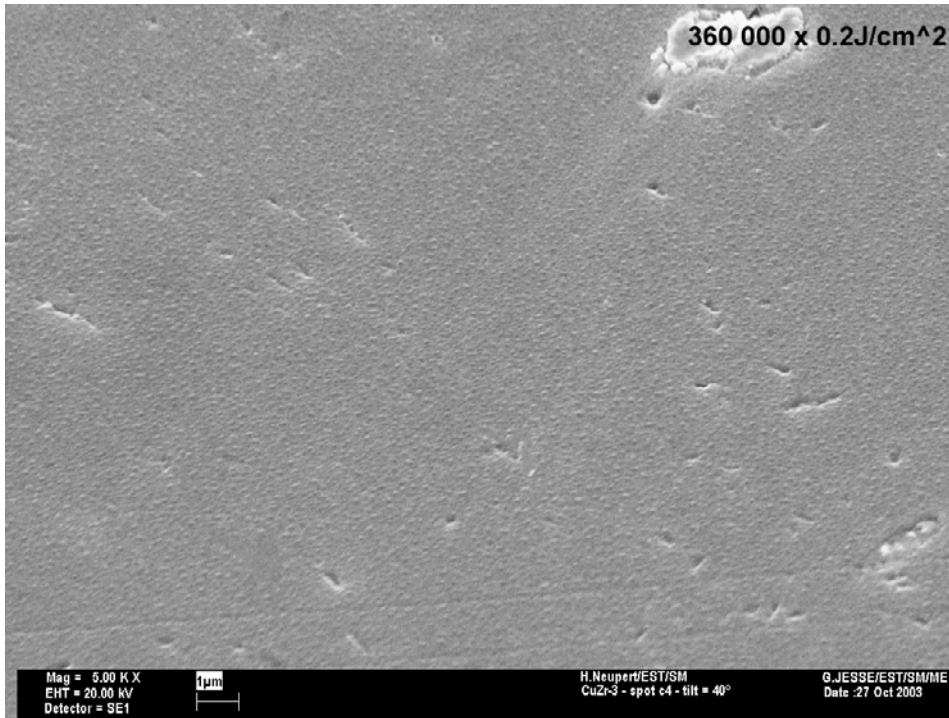


Cu/Zr 240000 shots



Cu 240000 shots

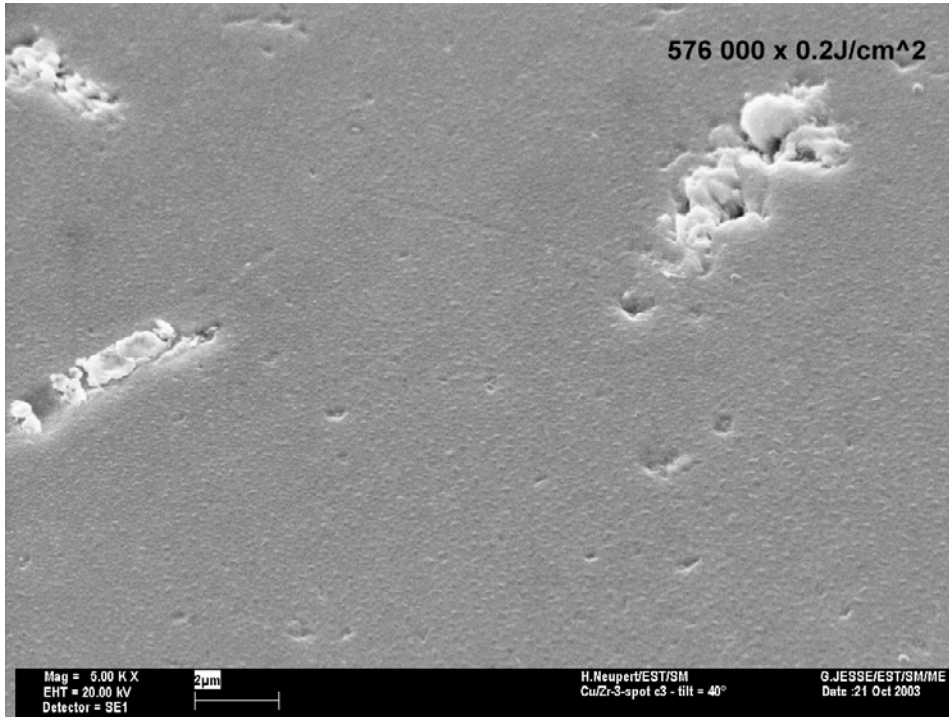
Comparing Cu/Zr with Cu at $\Delta T = 120\text{K}$



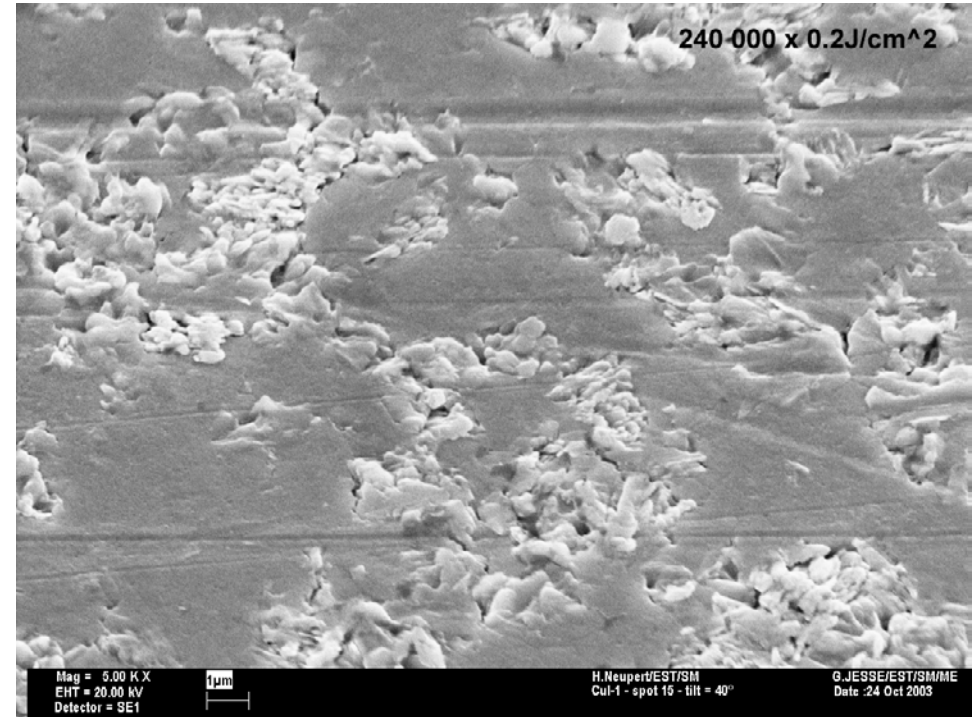
Cu/Zr 360000 shots

Cu 240000 shots

Comparing Cu/Zr with Cu at $\Delta T = 120\text{K}$

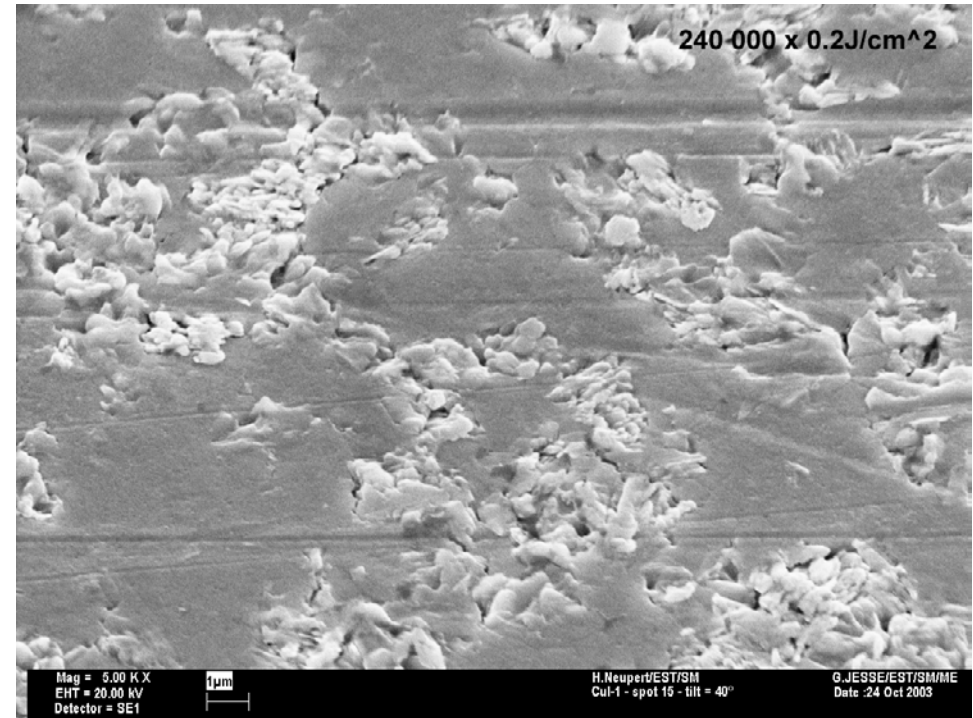
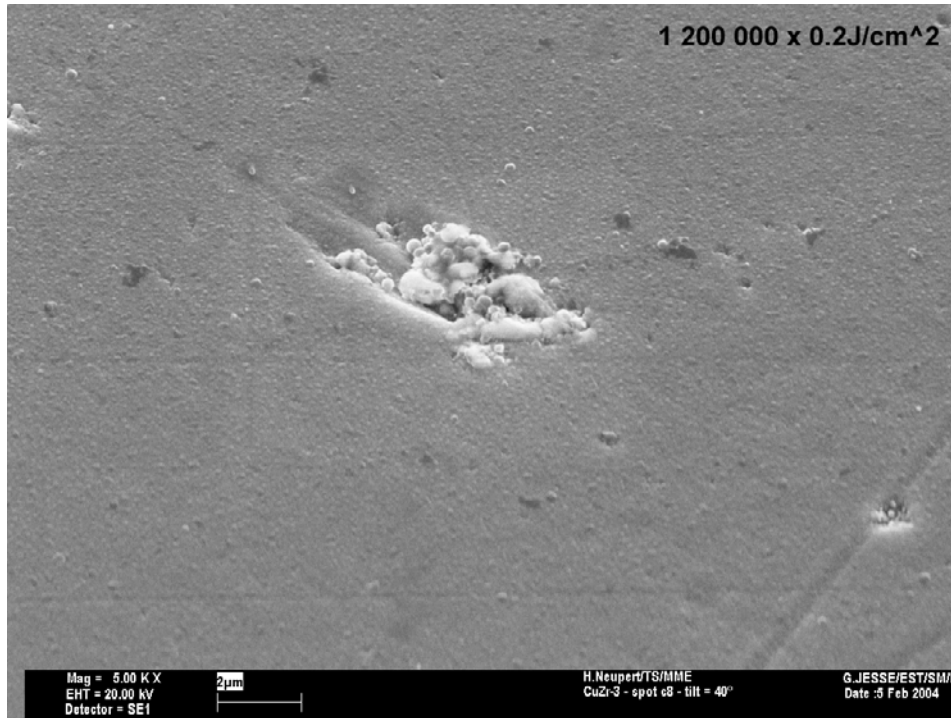


Cu/Zr 576000 shots



Cu 240000 shots

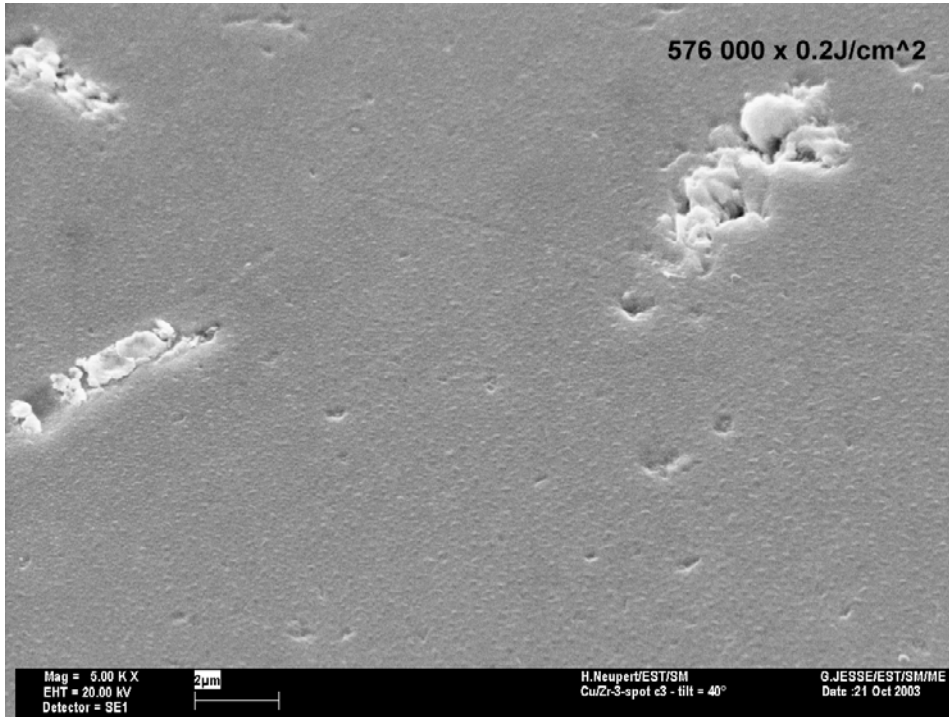
Comparing Cu/Zr with Cu at $\Delta T = 120\text{K}$



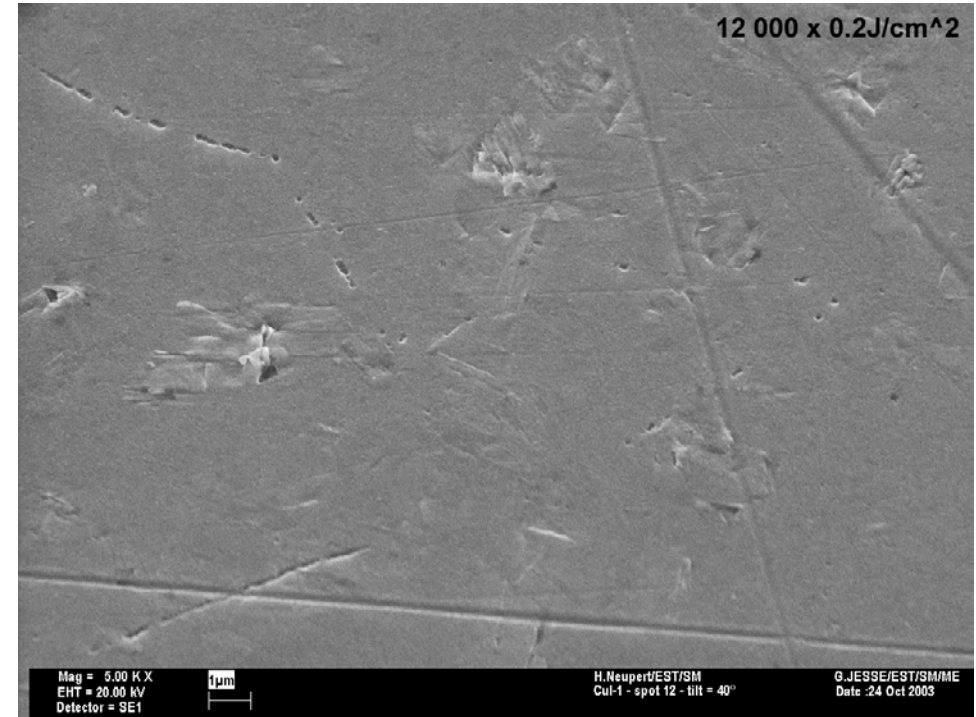
Cu/Zr 120000 shots

Cu 24000 shots

Similar damage after n cycles at $\Delta T = 120\text{K}$

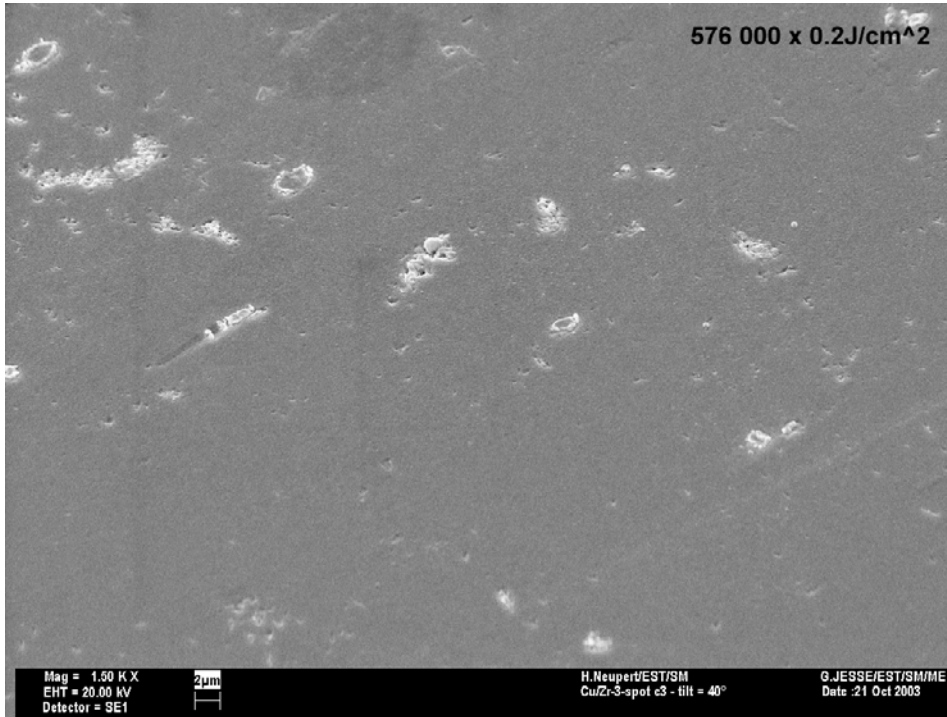


Cu/Zr 576000 shots



Cu 12000 shots

Defect density on Cu/Zr, $\Delta T = 120\text{K}$



- Picture 70 μm x 48 μm
Defect count ~ 20
Copper degrades more evenly distributed (at much lower shot numbers)

Cu/Zr 576000 shots



Laser pulsed heating – Fatigue tests



Conclusions drawn of electron microscope pictures

- At same ΔT Cu/Zr shows same surface damage (density) after 50 times more cycles
- Quality of damage is different, Cu/Zr breaks more locally compared to Cu which degrades more evenly distributed