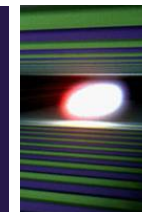


Surface Investigation of Samples Extracted from Prototype Cavities for European XFEL

W. Singer, X. Singer, A. Ermakov, K. Twarowski, S. Aderhold (DESY, Germany); F. Schölz (W.C. Heraeus, Germany); P. Michelato, L. Monaco (INFN, Italy)

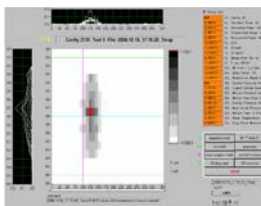


Abstract

Few cavities of the 4th and 6th cavity generation treated accordingly the XFEL recipe have shown performance of ca. 15-17 MV/m caused by thermal break down without field emission. The T-map analysis detected the quench areas mainly close to the equator. Optical control by high resolution camera and non-destructive X-Ray radiography have been applied and allowed to monitor the defects in some cases with good correlation to T-map observation. In order to get more detailed information of defects some samples have been extracted from cavity and investigated by light microscope, 3D- microscope, SEM, EDX and Auger spectroscopy.

Cavity 1

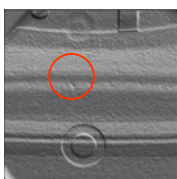
Preparation:
90 μm EP (ACCEL), alcohol rinsing, HT 800° C, 60 μm EP (DESY), HPR, alcohol rinsing, 6 x HPR, tank welding, 6x HPR, baking at 126° C.
Results:
Eacc = 16.6 MV/m,
Qo=1.8·10¹⁰ limited by quench, small FE in some modes, no Q disease.



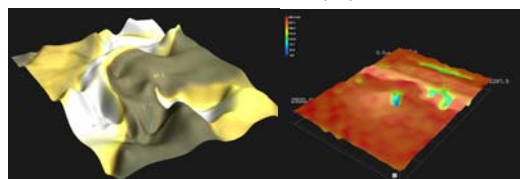
T-map: quench found in cell 5



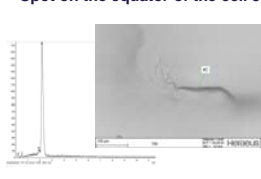
High resolution Kyoto-Camera. Spot on the equator of the cell 5



X-Ray imaging. Spot area marked. Washer as a reference

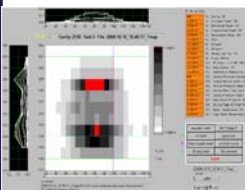


Sample 1, equator, 3D images. Bump and hole up to 200 μm deep in the spot area



No foreign material inclusions detected by EDX. Defect is probably something like welding beard

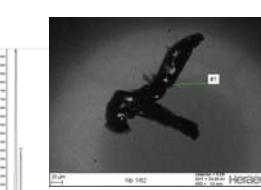
Cell 1, Quench at 16 MV/m



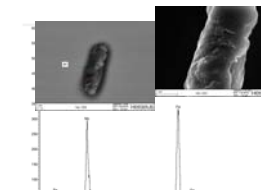
T-map of cell 1



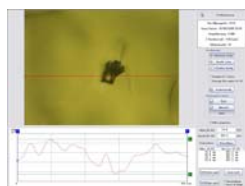
High resolution optical cavity control



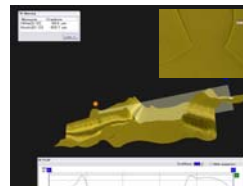
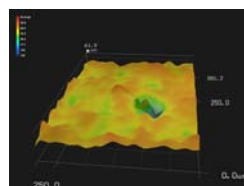
Sample 62 (away of equator): Many spots are detected. EDX of the biggest spot: C and O found



Sample 62: Iron found



Cell 1, Sample 25 (equator). In many cases spots seem to be like cavern.



Steps on welding seam of ca. 70 μm even after EP

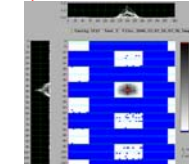
Cell 5, Quench at 23,3 MV/m on equator

Cavity 2

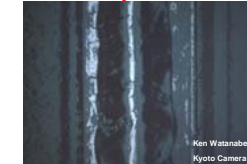
Preparation:
Ca.145 μm EP (DESY), HT 800° C, ca. 10 μm BCP-Flash (DESY), alc. rinsing, 6x HPR
Results:
Eacc = 16.2 MV/m,
Qo=1.8·10¹⁰ limited by quench, no X-Rays.



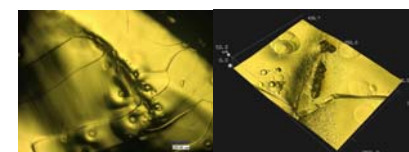
Cell 6, Quench at 16,2 MV/m on equator



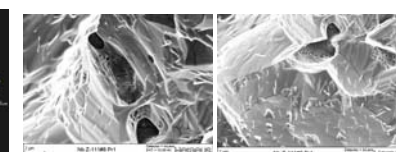
T-map: quench in cell 6, equator



High resolution optical inspection of the cavity

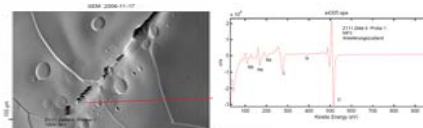


3D Microscopy

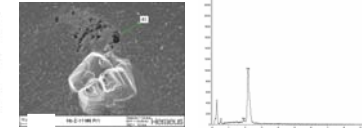


SEM

Holes with sharp edges along the grain boundaries are detected on the quench area. Pits around the holes.



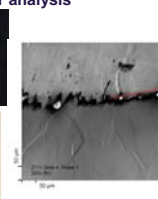
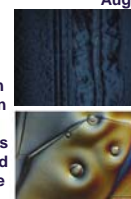
Auger analysis



EDX analysis

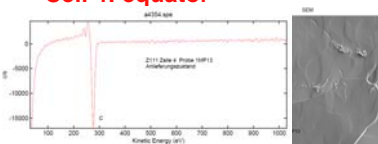
Auger analysis did not found foreign material in the quench area. EDX analysis found increased content of carbon in black spots close to quench area

Pits. Pits detected in all cells. On each odd half cell pits pronounced much more



Carbon in the black spots found by Auger

Cell 4: equator



Carbon mostly disappeared after 500 nm sputtering

Summary

Cavity 1: Quench area 16 MV/m: Many surface inclusions with sizes from few μm to hundreds of μm detected by SEM. Most inclusions indicates increased content of carbon. Some inclusions indicates increased content of oxygen and carbon. One inclusion indicates increased content of iron

Cavity 1 : Quench area 23 MV/m: Defect detected by optical control is approved by SEM, 3d- and light microscopes. No foreign material is detected in the defect area.

Cavity 2 : Quench area 16 MV/m (cell 6): Several holes with sharp edges along the grain boundaries are detected on the quench area by SEM. Several pits observed around the holes. Auger analysis did not show any indication of the foreign material inclusions in the quench area. Small black spots close to quench area have been observed. EDX analysis has shown increased content of carbon in these spots

Cavity 2 : Cell 4: Many pits are detected. Several areas with black spots are detected close to equator. Two areas have been analyzed by Auger. Carbon detected in black spots. Carbon is adhered on the surface and disappeared after ca. 500 nm sputtering.