Max-Planck-Institut für Plasmaphysik, EURATOM Association

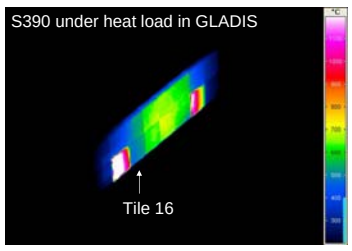
Micro-chemical analysis of highly heat loaded CFC/Cu interfaces from Tore Supra and Wendelstein 7-X

T. Höschen[a,*], H. Greuner[a], Ch. Linsmeier[a], M. Missirlian[b]

[a] Max-Planck-Institut für Plasmaphysik, EURATOM Association, 85748 Garching, Germany
[b] CEA, IRFM, F-13108 Saint-Paul-Lez-Durance, France

Motivation

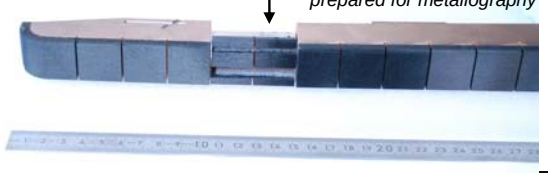
- HHF tests to evaluate the expected lifetime of Tore Supra TPL elements covered with different types of CFC N11
- Component S390 showed a higher failure rate after HHF testing in GLADIS
- Micro chemical investigations were performed on metallographically prepared cross sections of the CFC/Cu interface to check whether the bonding itself could be made responsible for the failure
- Comparison to W7-X advanced CFC/Cu bonding



The interface of the neighboring tiles 17 and 12 failed after a few cycles at 10 MW/m². These suddenly occurring defects resulted in a collapse of tile bonding within the following 100-200 pulses.

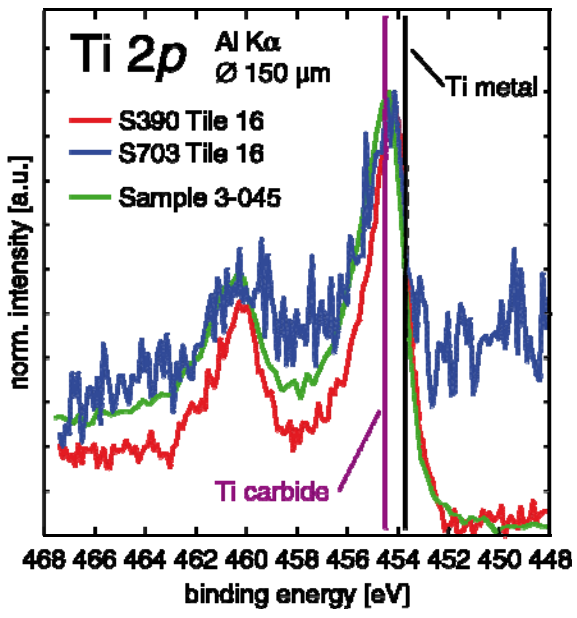
SATIR examination did not reveal any damages before HHF loading .

Tile 16
prepared for metallography



XPS

X-ray Photoelectron Spectroscopy measurements applied to determine the carbidic and metallic chemical states of titanium
➔ only carbidic Ti detected



Conclusions

Tore Supra TPL elements:

- 3000 cycles at 8 MW/m² performed, two elements covered with different N11 qualities
- Significantly different failure occurrence
- Differences in chemical composition of AMC bonding excluded as reason for failure
- Scatter in N11 quality confirmed as potential failure reason

Progress of W7-X bonding:

- Laser structuring better defined
- AMC bonding with improved elemental composition (addition of Si) [1]

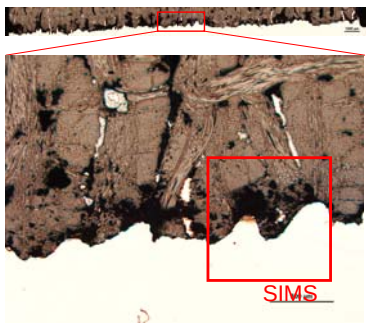
[1] Eidenberger et. al., Advanced engineering materials 2006, 8, No. 11, p.1092

SIMS

Secondary Ion Mass Spectrometry measurements were performed to visualize the spatial distribution of the alloying elements in the interfacial region

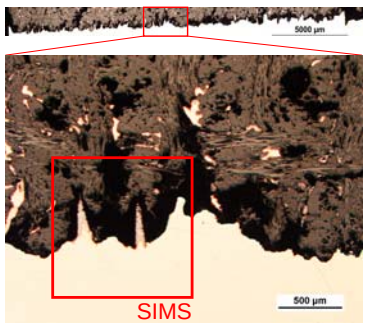
S390 Tile16: Tore Supra

CFC N11-98, slightly degraded
has never been installed in TS before
10 MW/m², 200 cycles
8 MW/m², 3000 cycles
no defect after loading



S703 Tile16: Tore Supra

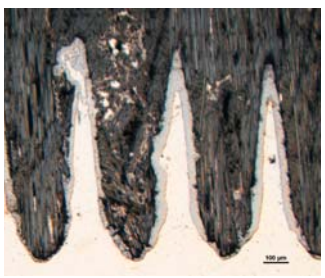
CFC N11-92, as specified
has never been installed in TS before
10 MW/m², 200 cycles
8 MW/m², 3000 cycles
no defect after loading

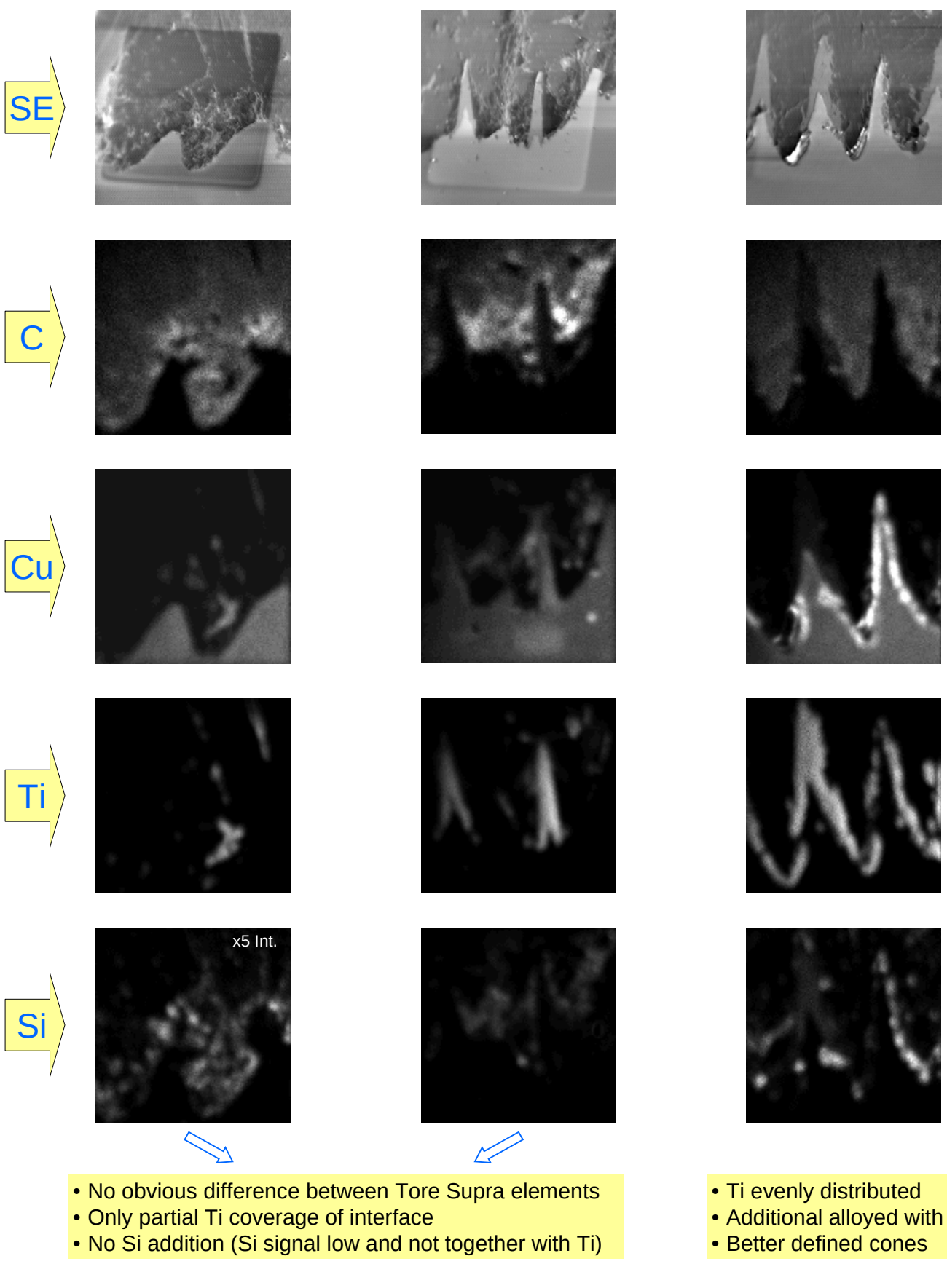


4S-045 t3: W7-X

improved AMC bonding
as delivered
10 MW/m², 5000 cycles

no defect after loading





- No obvious difference between Tore Supra elements
- Only partial Ti coverage of interface
- No Si addition (Si signal low and not together with Ti)

- Ti evenly distributed
- Additional alloyed with Si
- Better defined cones

*Corresponding author: till.hoeschen@ipp.mpg.de