European W components exposed to high thermal and high H fluxes - Selected results of GLADIS experiments-

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IEA Implementing Agreement for Fusion Materials Development

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HHF loading in GLADIS

Designed to test small material samples as well as full size components

Two completely independent ion sources allow superposition of different thermal and particle loading

➔ *Unique capability for operation with H, He or mixed H/He neutral beams and thermal loads*

H. Greuner et al. / Journal of Nuclear Materials 367–370 (2007) 1444–1448

Technical characteristics:

- Power 2 x 1 MW ion sources
- Acceleration voltage 15 - 50 kV
- Heat flux 2 - 45 (90) MW/m²
- Neutral beam ∅ 70 mm (80% central q')
- Pulse duration 1 ms - 45 s
- Target dim. up to 2 m (0.6 m vacuum lock)

Target cooling

- Water, RT 8.5 l/s, 25 bar

2015 upgrade to meet ITER and DEMO:

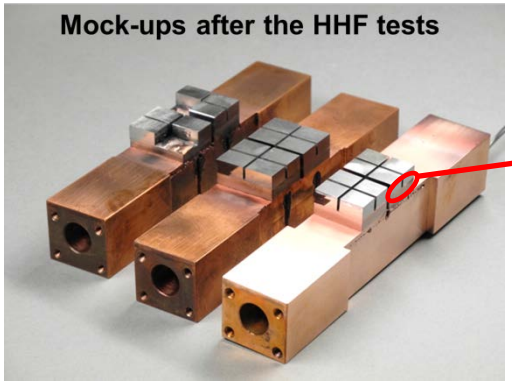
- T_{in} 20 – 230 ±1 °C, T_{out} max. 250°C
- Flow rate ≤ 2l/s , p ≤ 55 bar

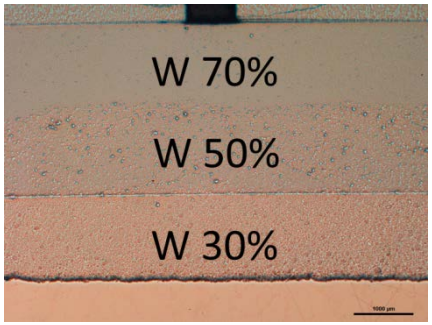
Results of HHF testing of W/CuCrZr multilayer composites

Results:

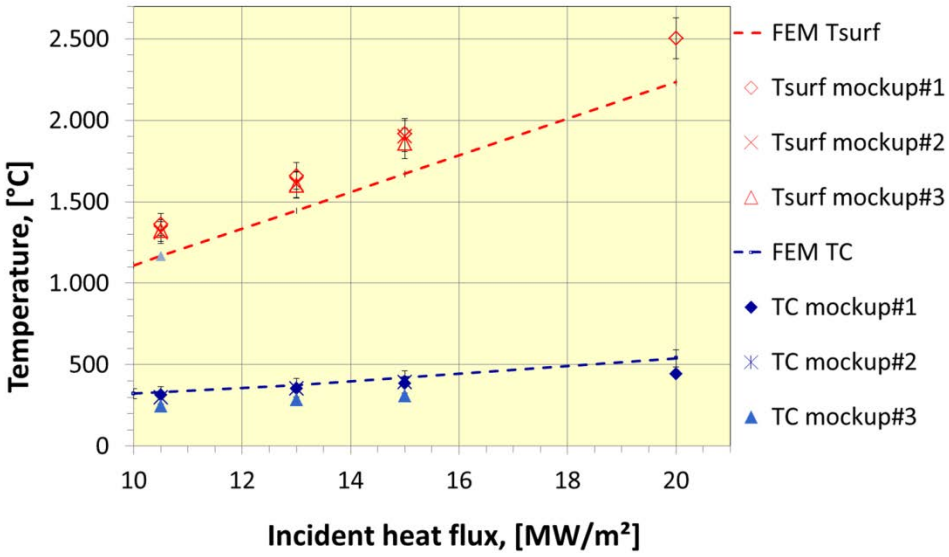
- The HHF performance was investigated up to 20 MW/m², one component failed due to manufacturing fault
- Confirmed the manufacturing technology of CuCrZr infiltration developed by TU Dresden and IPP
- Potential for further improvement: direct bonding between W and the functional graded composite

→ see oral You O44





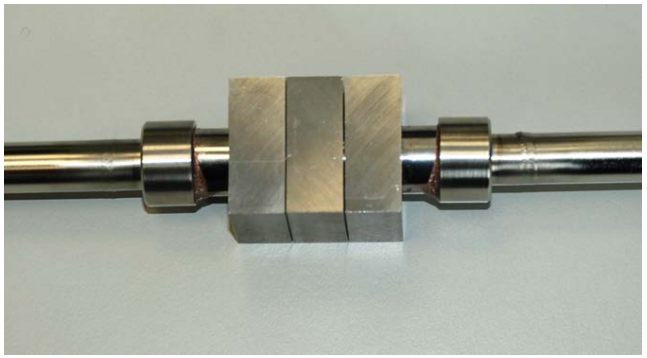
Graded composite after 20 MW/m² loading



References:
J.-H. You et al., Journal of Nuclear Materials 438 (2013) 1–6
A. Zivelonghi et al., Journal of Nuclear Materials 417 (2011) 536–539
H. Greuner et al.,http://dx.doi.org/10.1016/j.fusengdes.2015.02.011

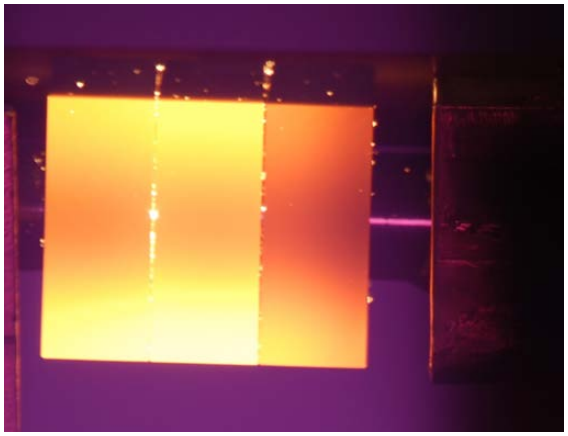
HHF loading of W monoblock on W/Cu laminate tube

Mock-up manufactured by KIT designed for water-cooled DEMO divertor (J. Reiser)
New idea: laminated W/Cu laminate tube

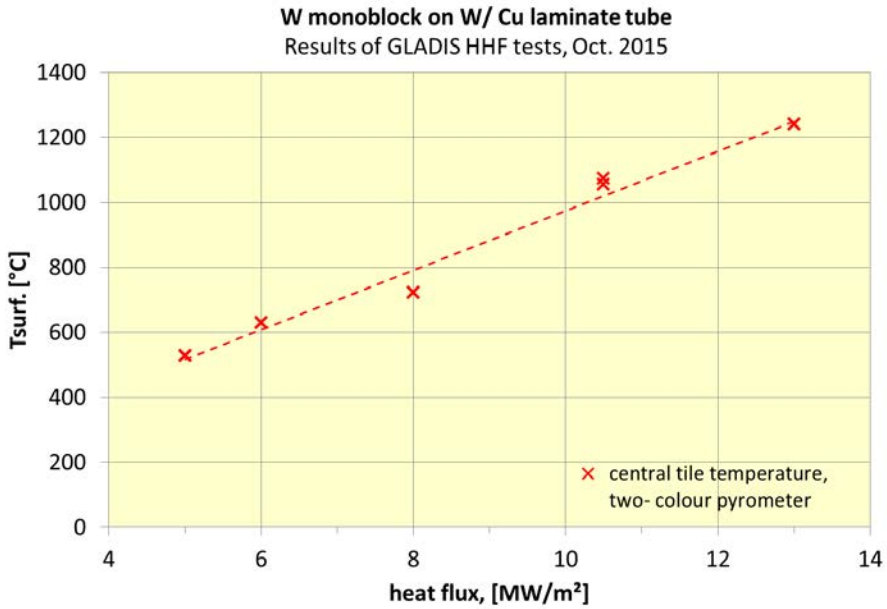


First results of HHF tests:

- Experimental evaluation of thermal performance, 5 – 13 MW/m², 15 s, v=10 m/s, T_{in}=20 °C, 10 bar
- Confirmation of the suitability of W- Cu lamir
- *further test in progress*



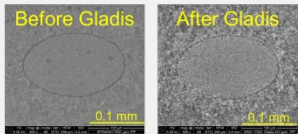
13 MW/m² heat flux, thermal equilibrium



Further material investigation and component test activities

Divertor components

- W fibre / W composites, sample test
  - Next step: component tests

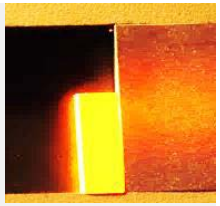


- W- Cu composite, concept improvement, component tests
- Continuation of component development with KIT
- ITER W monoblock components, development of IR QA assessment method
- Component test for W7-X, ASDEX upgrade, WEST…

HHF materials

- Self-passivating W-Cr alloys sample
  - Next step: component tests
    → Po3-29, Po4-31

Image of the 10 x 5 x 1.5 mm³ sample at the end of loading
Tsurf ~ 1000 °C



Basic research

- Basic research on H/He loaded W materials, erosion studies, H/ He inventory
- Behaviour of H/He damaged W surfaces under ELM like loading, in cooperation FZJ