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HELMHOLTZ ENERGY MATERIALS CHARACTERIZATION PLATFORM

Innovative Materials and Processes for Liquid Metal Energy Conversion Systems (HEMCP-AMTEC)

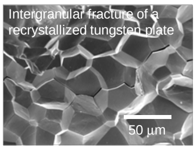
Innovative tungsten (W) pipes, surface alloyed metals and innovative ceramics

J. Reiser, J. Hoffmann, U. Jäntsch, M. Klimenkov, A. Weisenburger, G. Müller

Institute for Applied Materials, Applied Materials Physics (IAM-AWP), Institute for Pulsed Power and Microwave Technology (IHM)

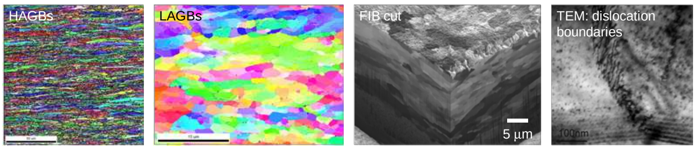
Introduction

Tungsten (W) is the metal with the highest melting point among all metals (T_m = 3422°C (3695 K)). One of the major deterrents to the application of tungsten lies in its low-temperature brittleness, which raises the question: How to make tungsten ductile?



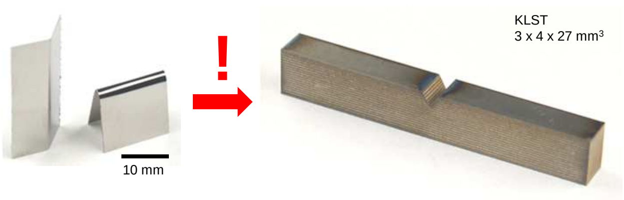
Ductilisation of tungsten through cold rolling

Cold-rolling improves (i) the brittle-to-ductile transition temperature (BDTT), (ii) the toughness, K_{IQ}, (iii) the R-curve behavior and (vi) the elongation at break. But why?



Ductilisation of tungsten through the synthesis of a tungsten foil laminate

The motivation of the laminate is to produce a bulk material that retains the ductility and toughness of severe cold-rolled foils.

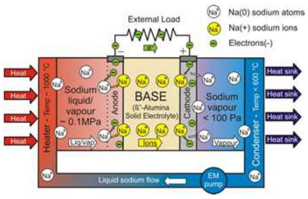


Applications for tungsten foil laminate pipes

Due to its excellent behavior towards liquid metals, tungsten foil laminate pipes are an interesting candidate for the alkali metal thermal to electric energy conversion (AMTEC).

Introduction

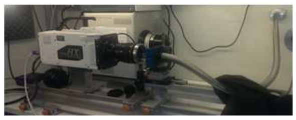
In AMTEC Na temperatures of 800°C will be reached. Compatibility of steels and Ni basis alloys at this conditions is not given. Use of AMTEC as CSP receiver



Improvement of:
Na boiling by surface engineering
Thermal fatigue at high temp
Materials in contact with hot Na
Ceramic metal brazing

Experimental Set-Up's (HEMCP)

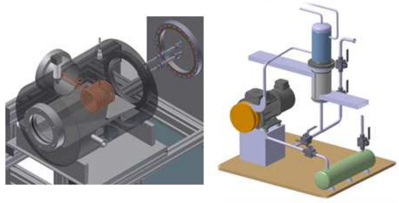
GESA-SOFIE – Pulsed electron beam facility with fast online diagnostics



Surface alloying for improved material compatibility

Change in surface roughness for improved Na boiling
Fast online diagnostics allow detailed understanding
➔ required for process modelling

SOLTEC-TCT – Na loop for Thermal Cycling Tests

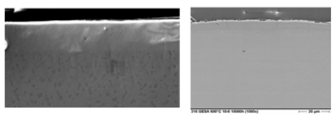


Simulation of clouds
Day night cycle
High temperature
ΔT: 650°C – 881°C

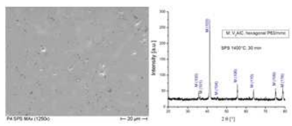
Na loop with inductive heating section – in construction

Materials to be considered and tested

Two temperature regions:<750°C:
HT austenitic steels + surface alloying of Mo, Ta, Al formers + pre-oxidation, ….
and < Tboil of Na (881°C):
Ni base alloys + surface alloying, Ceramics: Maxphase, Carbides, laminated tungsten



W alloyed in TiAl FeCrAl alloyed in steel



V2AlC by SPS