End-of-Year Meeting WPRD LMD 2025 - ENEA
Improved W-mesh based CPS production and corrosion characteristics of mesh and barrier technology

M. Bugatti, L. Ferrante, F. Zarotti,
M. Iafrati, S. Roccella

This work has been carried out within the framework of the EUROfusion Consortium, funded by the European Union via the Euratom Research and Training Programme (Grant Agreement No 101052200 — EUROfusion). Views and opinions expressed are however those of the author(s) only and do not necessarily reflect those of the European Union or the European Commission. Neither the European Union nor the European Commission can be held responsible for them.

Status of the Deliverable

Aim: Improve CPS reliability by optimizing mesh design and corrosion protection

Activities:

Activity 1:
Create lower roughness W-mesh and evaluate performance after wetting with **Sn and Ga**

Activity 2:
Evaluate wetting/corrosion characteristics of mesh and corrosion barriers with **Sn and Ga**

Status since mid-term meeting:

Activity 1 – W-mesh Roughness

- Perform Ga wetting tests for comparison against Sn
- Microstructural & interfacial analysis (cross-sections, EDS) (Ongoing)
- Measurement of surface roughness for comparison against Sn

Activity 2– Wetting & Corrosion

- Extend corrosion screening to Ga at comparable conditions
- Microstructural & interfacial analysis (cross-sections, EDS) both on Sn and Ga samples (Ongoing)

1. Progress Since Mid-term: Mesh Roughness

2025 Activities identified lowest surface roughness tungsten yarn woven in **herringbone pattern** wet by liquid Sn:

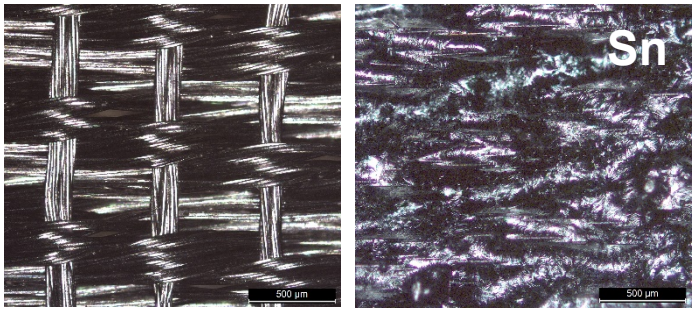
- Remaining activities focus on roughness mapping after **Ga wetting**

	Yarn Woven Side a	Yarn Woven Side b	Best sample 2024	Reference sample(*)
S_q [µm]	19	51	125	30
S_a [µm]	**17**	**42**	**112**	**24**
S_z [µm]	77	222	399	222

*A. Vertkov et al. / Physics of Atomic Nuclei 83 (2020) 1116–1123

Received requests for Sn-wet and not-wet CPS samples for HHF tests:

- OLMAT (CIEMAT)
- HADES (CEA)
- COMPASS-U (IPP Prague)



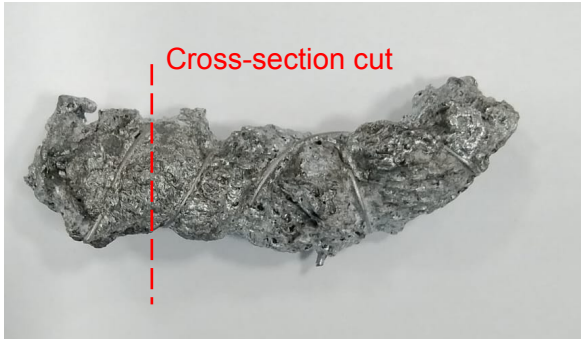
Herringbone pattern

Foreseen necessity to order new **raw material** from the supplier and **processing toolings** for 2026/2027 activities.

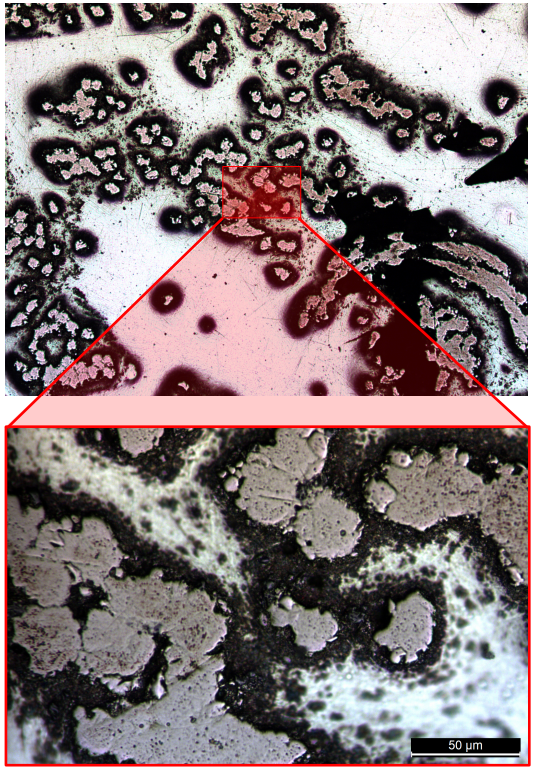
1. Progress Since Mid-term: Mesh Roughness

- CPS samples in woven **herringbone pattern** wetted by **liquid Ga**

- Wetting was investigated through metallographic cross section analysis
  - Bundle of W mesh was wet by liquid Ga to perform a cross-section micrography
  - Contaminants on W-Ga interface → EDS needed to clarify the nature of the interfacing contamination



Bundle of CPS mesh wet by liquid Ga

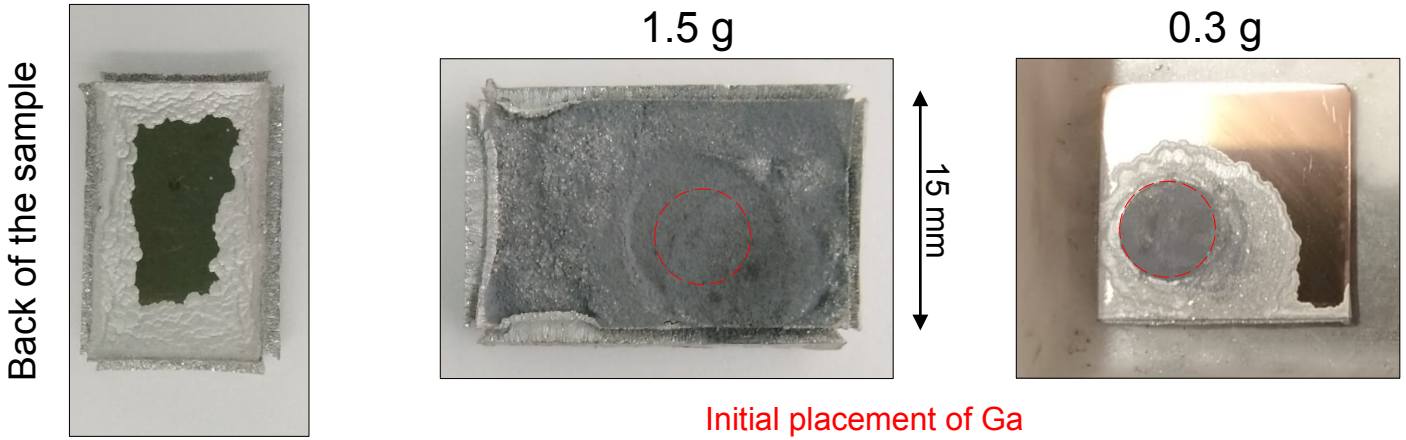


Micrography of tungsten fibers in Ga medium

2. Progress Since Mid-term: Wetting & Corrosion

- Bulk W is notably **corrosion resistant** against the attack of Ga even at high temperatures [1]. However Ga-CuCrZr interaction in the presence of a coating is not well known and must be investigated.

- Corrosion tests performed in conditions **as close as possible to Sn case** for direct comparison:
  - Coated samples exposed for 10 h at 400°C against a Ga droplet
  - Ga corrosion vs CuCrZr was benchmarked → LM test mass reduced from 1.5 g (Sn case) to 0.3 g

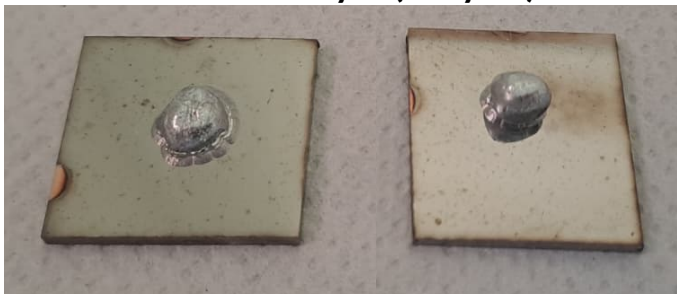


[1] T. O. Sullivan et al. "Corrosion resistance of structural materials to Ga2O at 1000° C." Journal of nuclear materials (2002)

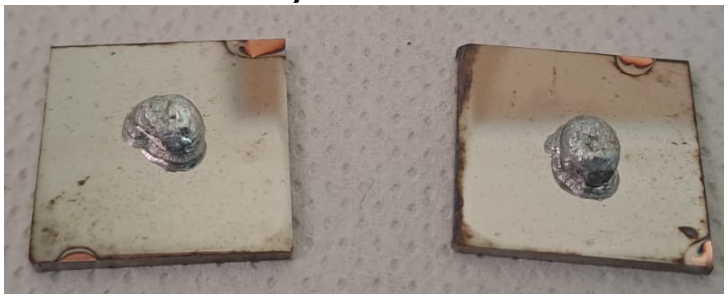
2. Progress Since Mid-term: Wetting & Corrosion

- The most promising coating morphologies presented at midterm for Sn were deposited at Politecnico di Milano on polished CuCrZr substrates and exposed to liquid Ga at ENEA.

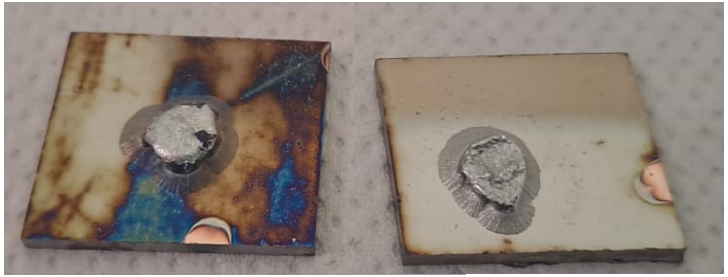
W-Al multilayer (3-layers)



Crystalline W



Amorphous WN

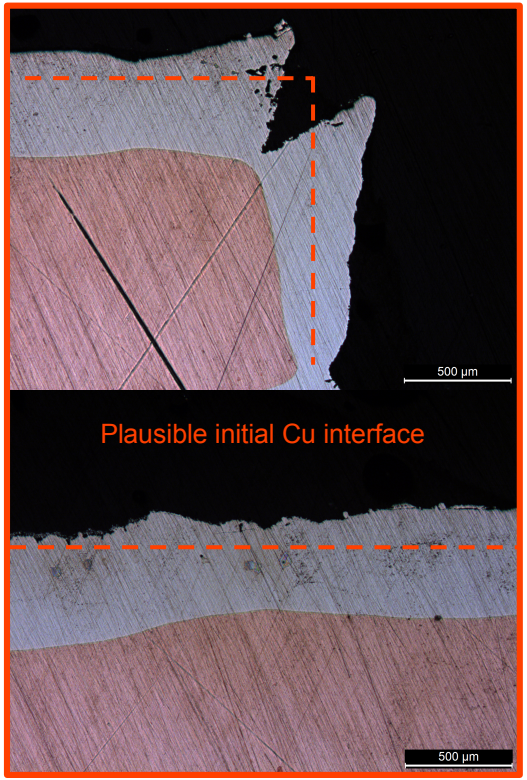


Crystalline WN

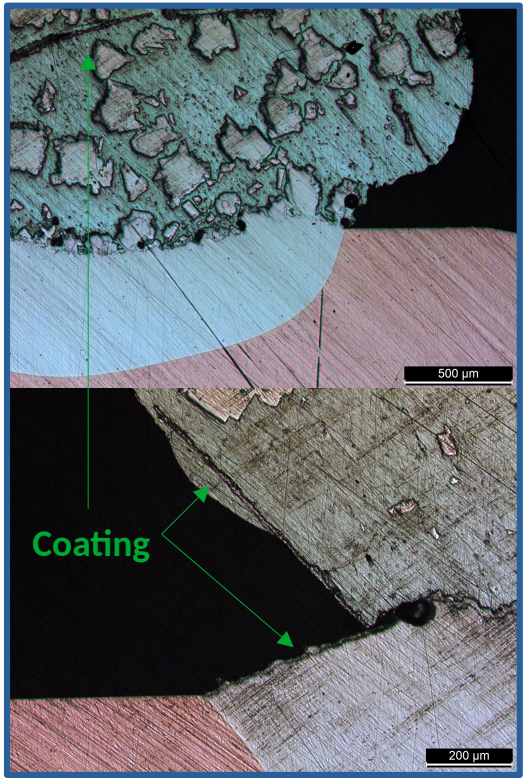
2. Progress Since Mid-term: Wetting & Corrosion

- Cross-section micrographs are **ongoing**. Preliminary results allow to compare corrosion with and without barrier:

Bare Cu



W-Al Coating



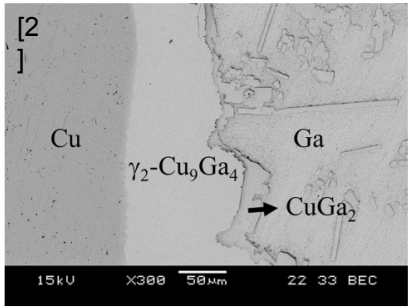


Fig. 2. BEI micrograph of Cu/Ga reaction at 350°C for 72 h.

- Large Ga spread on bare substrate indicates fast **reaction-driven damage propagation**
- Ga demonstrated **higher corrosive potential** against CuCrZr
- Samples analysis to be completed in order to asses changes in coatings performance

[2] S. Chen et al. "Interfacial Reactions in the Cu/Ga/Co and Cu/Ga/Ni Samples." Journal of Electronic Materials (2019)

Perspectives and Activities for 2026-27

Activities to be completed:

Activity 1 – W-mesh Roughness

- Roughness mapping after Ga wetting (Sa, Sq, Sz)
- Complete the microstructural & interfacial analysis (EDS)

Activity 2– Wetting & Corrosion

- Microstructural & interfacial analysis (cross-sections, EDS) on Ga samples
- Sn/Ga corrosion comparison

Proposed Activities for 2026-27:

- Mechanical integration and Wetting of W-mesh on **coated cylindrical samples**
- **Thermal cycling** on coated samples
- Collaboration with 3rd year PhD student on **OpenFoam simulations** for wetting in CPS systems

SAPIENZA UNIVERSITÀ DI ROMA

Thank you for your attention