

Romanian participation at EUROfusion WPPRD and complementary research

- 1) *Acronym: WPPRD-RO*
- 2) *Contract no.: EURATOM-RO/CDI/2024-2-001*
- 3) *Funding program: PNCDI IV/5.9/5.9.2/Modul EURATOM-RO + GA101052200*
- 4) *Project duration: 23 months (2025.02.261 – 2026.12.31)*

Project Summary

Activities under Prospective R&D (PRD) are aimed at providing alternative, risk-mitigating, options for DEMO and/or a fusion power plant, targeting the delivery of commercially viable fusion energy. INCDFM proposed contribution for the Work Package PRD is focused on HHFM processing and characterization. The processing part covers bulk W-composites with various dispersed powders consolidated using FAST (field assisted sintering technique) and HPS (hot press sintering). Metallic or ceramic nanometric particle dispersions will be included in W, aiming to decrease BDTT of the material and also to increase its fracture toughness. Such dispersions are also expected to increase the recrystallization temperature of the material, thus making it more suited for extended high temperature exposure without a significant degradation of its properties. After an initial fast forward screening of ZrC, diamond, SiC, Cr and Fe, the materials based on ZrC and Cr dispersoids have shown interesting properties. The other have been down-selected. Optimization of the morphology of W-ZrC material has led to a plastic behaviour observed at temperatures as low as 300 C, while the recrystallization temperature was estimated at more than 1400 C. Also, after optimization of the grain-size ratio of the Cr/W powders, an uniform dispersion of Cr particles has been observed after the SPS consolidation. Work is in progress to evaluate the thermal stability of such materials. Also work with V is in progress aiming to test the possibility to obtain an in-situ coating of W grains. Other possible dispersoids as HEA or Zr are foreseen for investigations in the present project. The best materials obtained will be further developed and tested in fusion relevant conditions. The complementary part of the project is focussed on testing materials behaviour under severe conditions, closer to that expected in a fusion reactor. IAP has an adequate infrastructure to produce various types of materials and components following the task specifications of the HHFM work group in WPPRD while INFLPR has facilities for sample irradiation using high and low energy electrons beams and also plasma guns.

Summary of results obtained in 2025

The 2025 work was focused on W-ZrC, W-Cr and W-V composites produced with powders with different W grain sizes and nanometric dispersions. A complicated interdependence between W grain sizes (as produced and after annealing/recrystallization) and the dispersoids size/content is driving the mechanical behavior of the samples in the case of W-ZrC material.

For the best W-ZrC material a flexural strength up 1.7 GPa is obtained from 300 C upward which outperforms the pure W material by a factor of 3. From this point of view, our W-ZrC material produced by a powder metallurgy route is one of the top materials considered in the frame of EUROfusion as possible alternative for divertor armor in DEMO. Further test will be performed in the next years.

For W-V material it was demonstrated that the partial coating of W grains by the nm V powder is preserved also after the thermomechanical treatment performed to increase the density.

6 MeV electron irradiation of the W-V specimens shows that the exposed surface is more affected when the V content increases.

Dissemination and visibility

Conference contributions:

A. Galatanu, M. Galatanu, Advanced tungsten materials produced in NIMP for divertor armor application in thermo-nuclear fusion reactors, presentation at IBWAP-2025, Constanta, Romania, 9-12 July 2025.

- M. Galatanu, M. Enculescu, I. Assahsahi, A. Galatanu, Morphology and microstructure of advanced Tungsten materials with Cr and V dispersoids intended for nuclear fusion applications, Oral presentation at IBWAP-2025, Constanta, Romania, 9-12 July 2025.*
- M. Galatanu, W. Pantleon, M. Enculescu, M. Grigoroscuta, A. Galatanu, Tuning Thermophysical and Mechanical Properties of Tungsten Materials with Dispersed Nanometric ZrC Processed by Powder Metallurgy Route, Oral presentation at MRS Fall Meeting 2025, Boston, MA, USA, 29 November–7 December 2025*

*Contact person: Dr. Magdalena Galatanu
E-mail: magdalena.galatanu@infim.ro*