

# ESTEP SPRING DISSEMINATION EVENT

17-18 FEBRUARY 2026 - BRUSSELS (BELGIUM)

Unlocking the effect of  
residual elements via the  
NANOengineering of  
Sustainable MARTensitic  
steels (Nano-S-Mart)

Pello Uranga

[puranga@ceit.es](mailto:puranga@ceit.es)

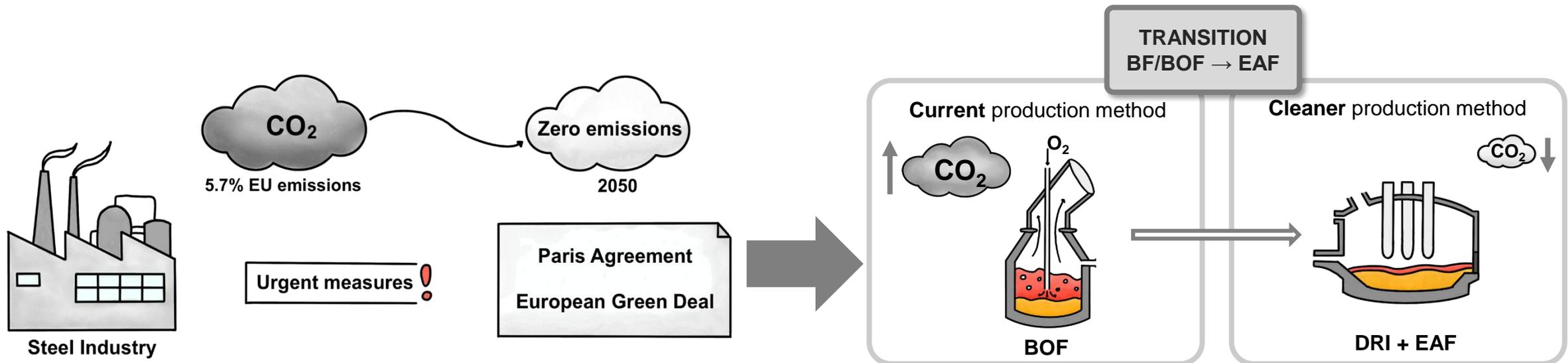


# CONTEXT AND MOTIVATION

## Industry Challenges & Climate Commitments

The European steel industry faces high market pressure and significant carbon reduction goals, with steel production currently contributing 5.7% of the EU's greenhouse gas emissions.

Leading steel producers, including ArcelorMittal, are dedicated to the EU's zero emissions target by 2050 (Green Deal), shifting from carbon-intensive BF/BOF processes to low-carbon options like DRI and EAF.



# CONTEXT AND MOTIVATION

## Industry Challenges & Climate Commitments

This shift raises concerns about the impact of residual elements (e.g., Cu, Sn, As) on material processability and final properties, requiring a reassessment and potential re-engineering of each steel grade's design.

Within the spectrum of steel products, martensitic steels are crucial across key sectors vital for EU competitiveness, encompassing construction, automotive, energy, and defense.



**NANO-S-MART aims to leverage innovative low CO<sub>2</sub> production methods, combining DRI and EAF, to enhance scrap utilization (ESU) in as-quenched and quenched+tempered (Q&T) martensitic steels.**

**HORIZON-CL4-2024-TWIN-TRANSITION-01-46: innovative steel applications for low CO<sub>2</sub> emissions**

Project No: 101178431

Dates: 2024-11-01 to 2028-10-31, 48 months



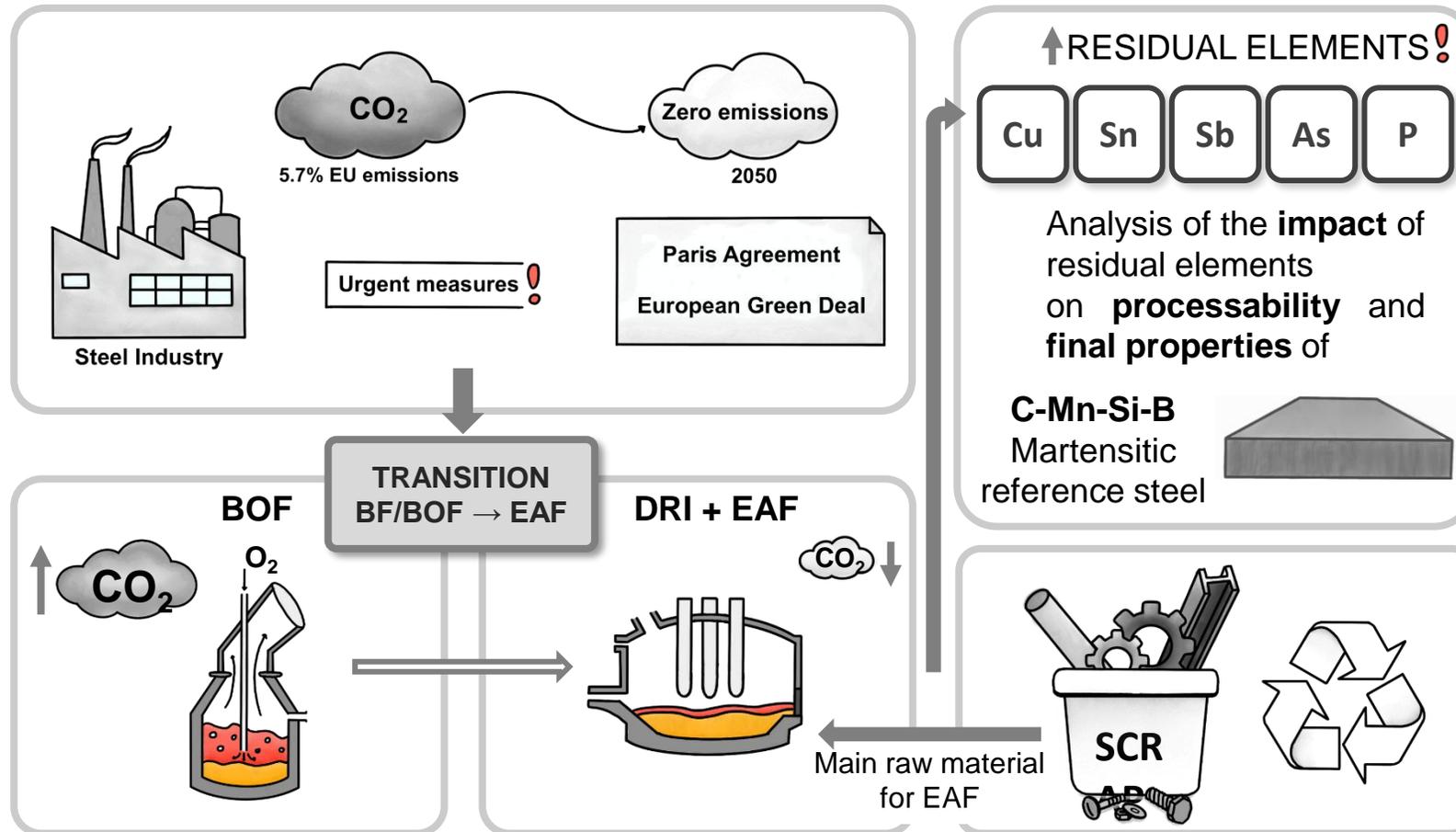
# PROJECT OBJECTIVES

- The project is dedicated to **study the impact of increased scrap use** in as-quenched and quenched+tempered **martensitic steels**, by systematically **mapping** the effects of **residual elements across macro-, micro-, and nano-scales**.
- The **main goal** is to **develop guidelines** and **validate new technologies** to improve steel quality and sustainability.
- In addition to environmental benefits, **NANO-S-MART enhances** the steel industry's **competitiveness**. By advancing specialized steels, the project contributes to sustainable growth, creates employment opportunities, and supports local economies across Europe.

# PROJECT OBJECTIVES

## NANO-S-MART

The impact of five residual elements (Cu, Sn, As, Sb, P) on the material processability (C-Mn-Si-B reference steel) and macroscopic properties of the end product will be evaluated, as well as their effects at the nanoscale around the most critically impacted microstructural features.



# CONSORTIUM

## Small and very complementary consortium

**3 high-ranking RTOs (CEIT, KIT and MPIE) and 1 University (UGent) will be involved in the developing of breakthrough innovative solutions for martensitic steels. One key industrial partner (OCAS-ArcelorMittal) devoted to push always forward their technology solutions.**



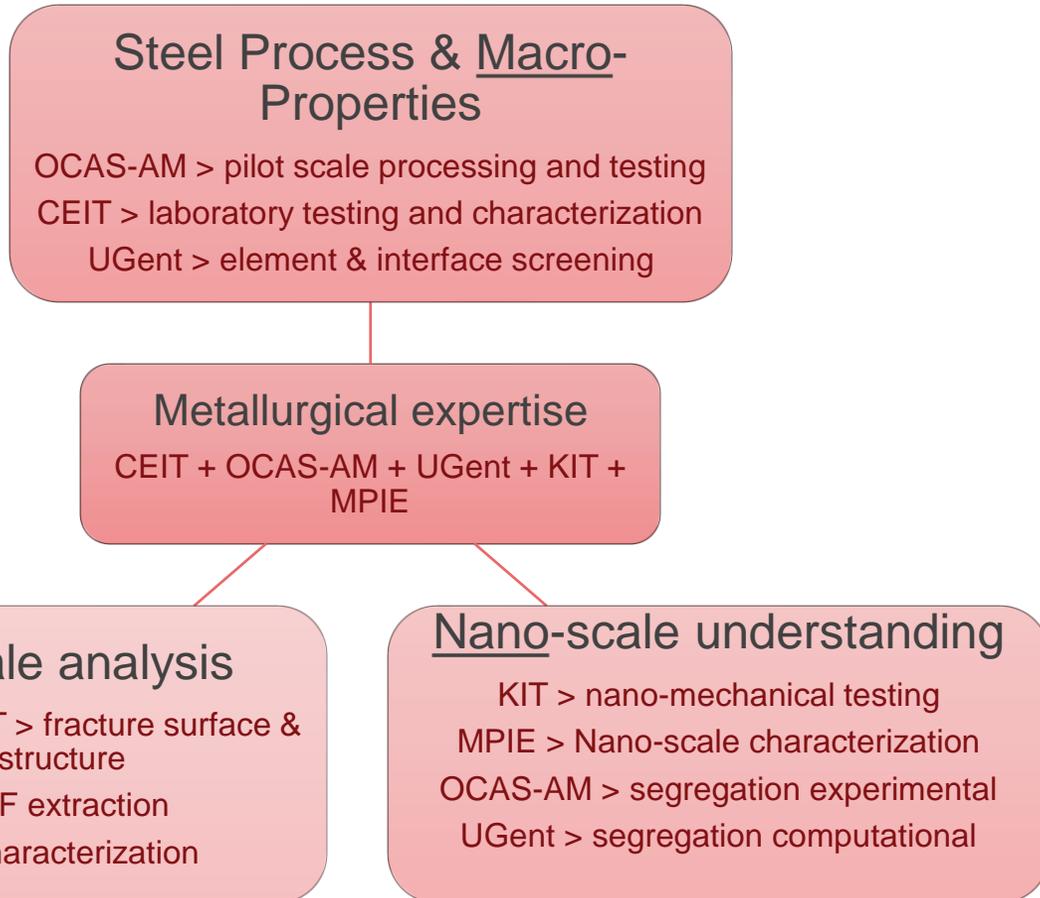
### Participants

1. CEIT-ASOCIACION CENTRO TECNOLOGICO CEIT (ES)
2. OCAS-ONDERZOEKSCENTRUM VOOR AANWENDING VAN STAAL NV (BE)
3. UGent-UNIVERSITEIT GENT (BE)
4. KIT-KARLSRUHER INSTITUT FUER TECHNOLOGIE (DE)
5. MPIE-MAX PLANCK INSTITUT FUR EISENFORSCHUNG GMBHc (D) (DE)

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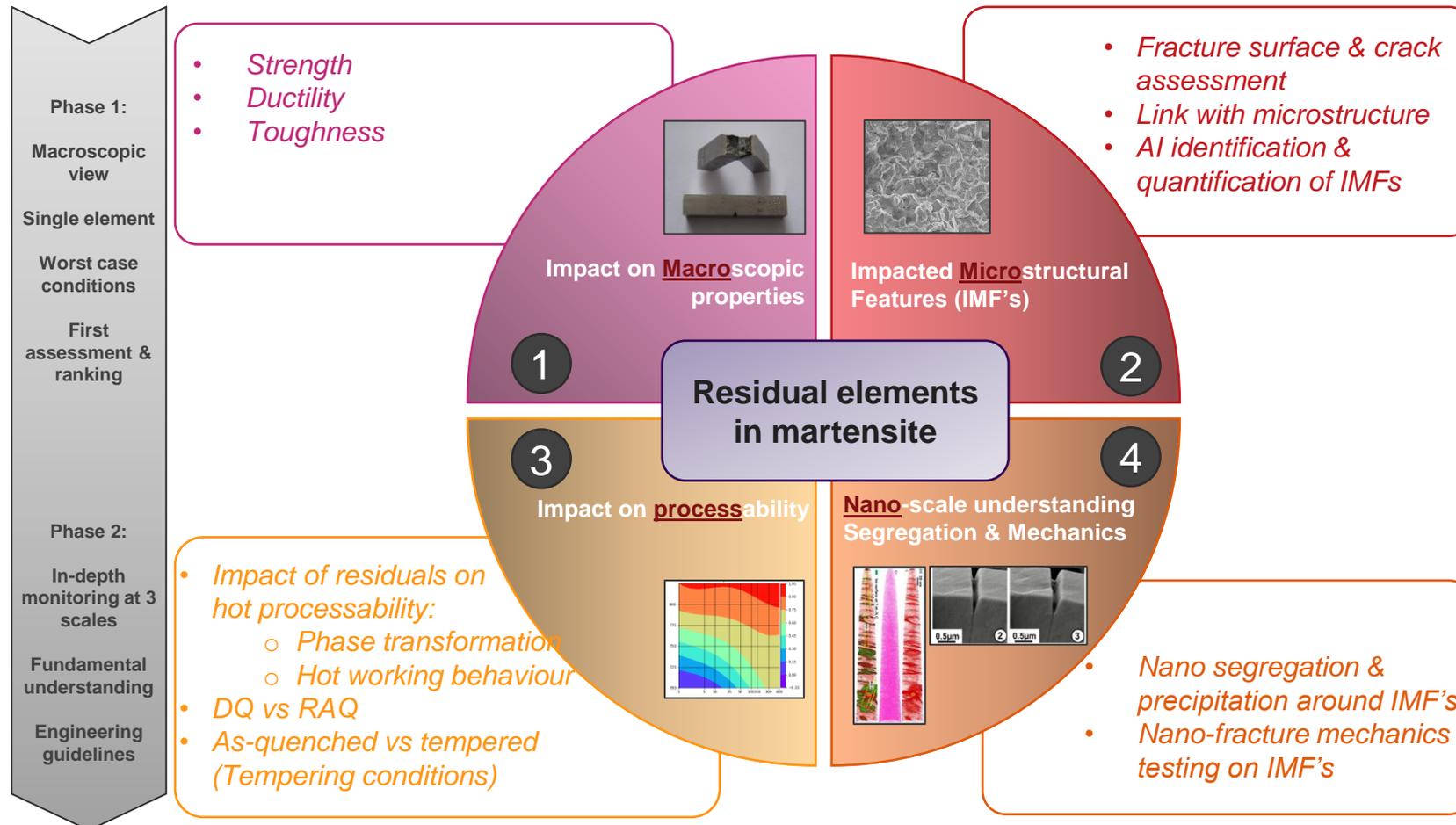
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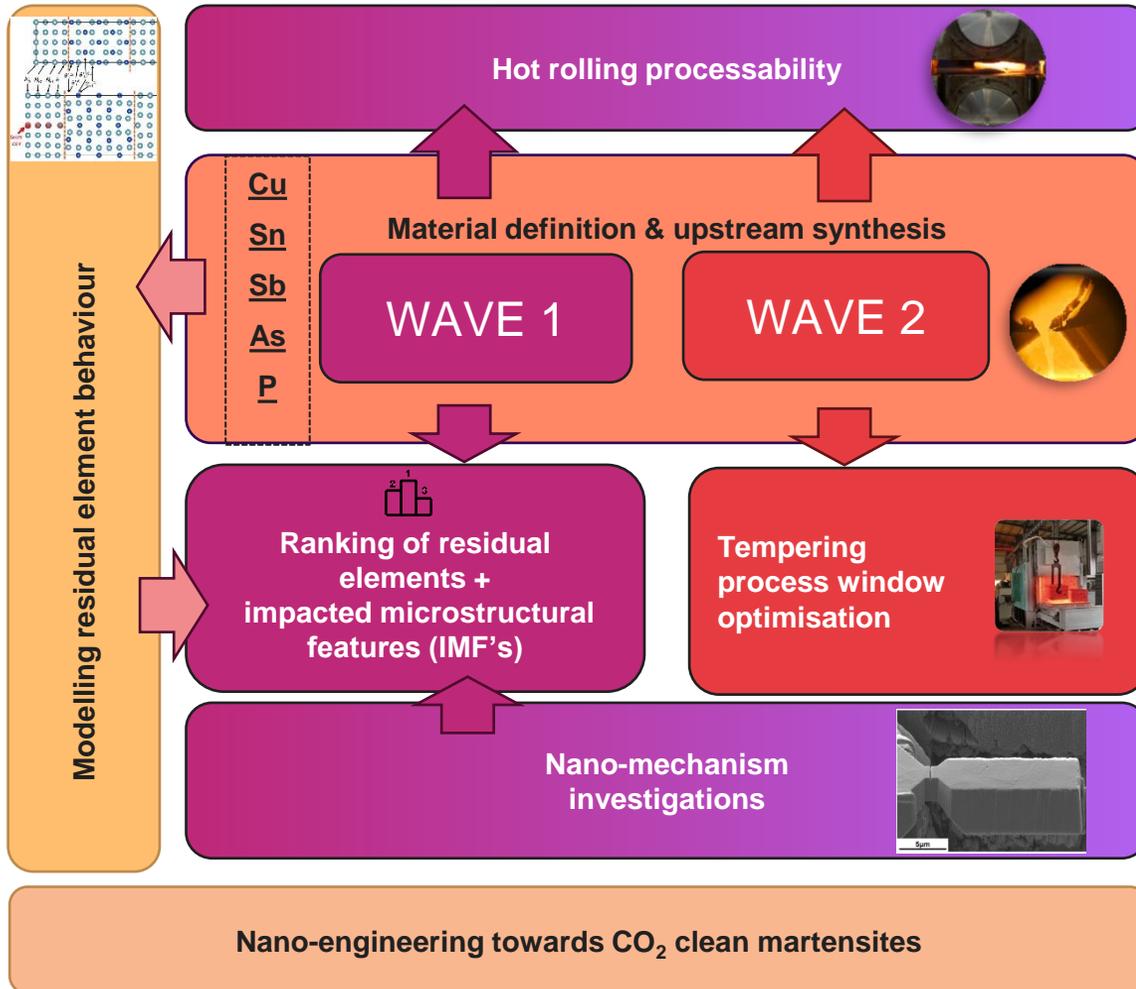
# WORK PLAN STRUCTURE

The NANO-S-MART project is structured in 4 pillars:

Investigations will be done on macro-, micro- and nano-level, which will be addressed through waves of materials in succession:



# PROJECT ACTIVITIES



- Wave 1 materials **produced**
- Hot Working processability (Wave 1) **ongoing**
- Impact of residuals after tempering treatments (Wave 1):
  - Mechanical tests: **completed**
  - Microstructural characterization: **ongoing**
- Modelling of residual element distribution: **ongoing**
- Nano-mechanism investigation: **ongoing**
- LCA Analysis: **ongoing**

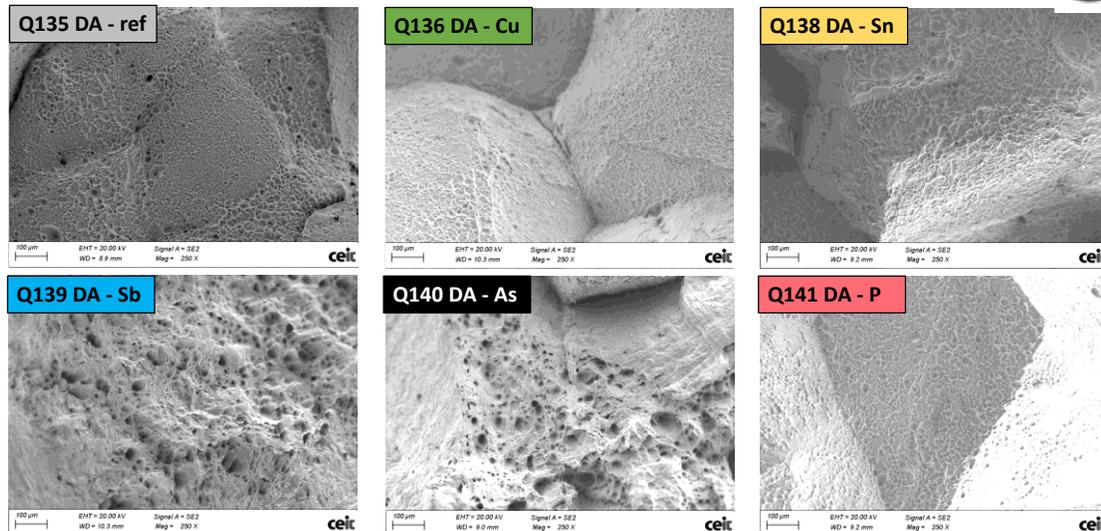
# PROJECT ACTIVITIES



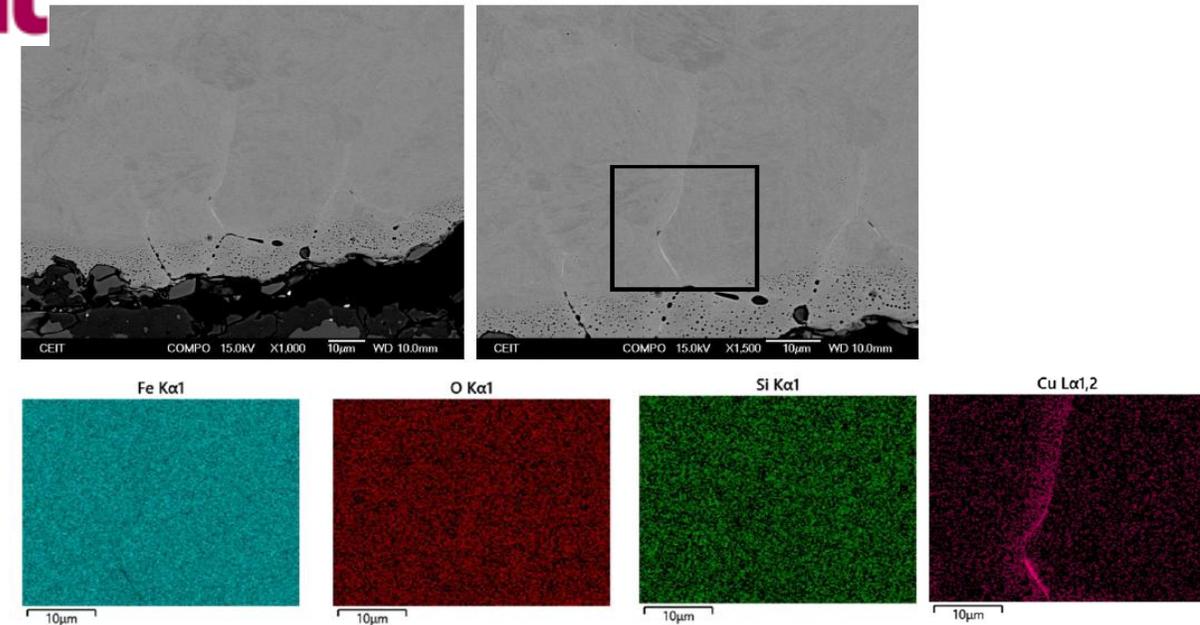
## Wave 1 material composition (wt%)

#	Description	C	Mn	Si	B	Cu	Sn	Sb	As	P
1	Reference	0.2	iso	iso	iso					
2	+ Cu	0.2	iso	iso	iso	0.2				
3	+ Sn	0.2	iso	iso	iso		0.07			
4	+ Sb	0.2	iso	iso	iso			0.04		
5	+As	0.2	iso	iso	iso				0.04	
6	+P	0.2	iso	iso	iso					0.02

## Fracture surfaces after hot ductility tests

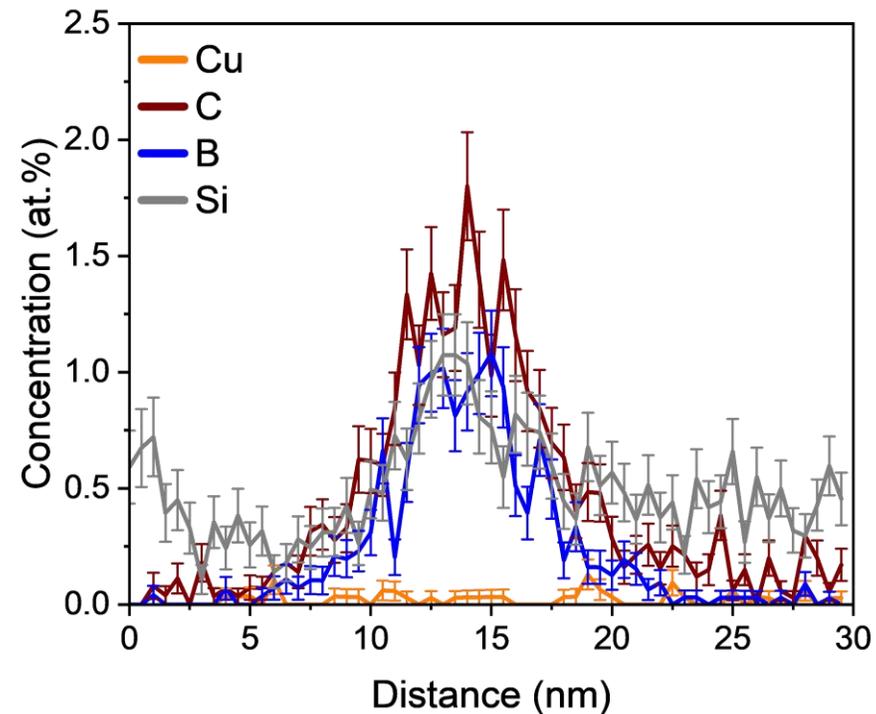
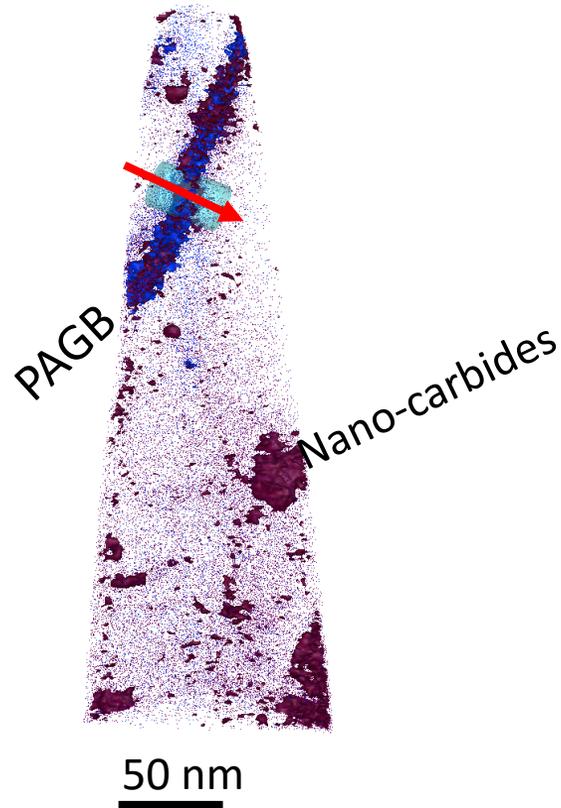


## Hot shortness analysis after reheating



# PROJECT ACTIVITIES

## Atom Probe Tomography: Residual element segregation observation



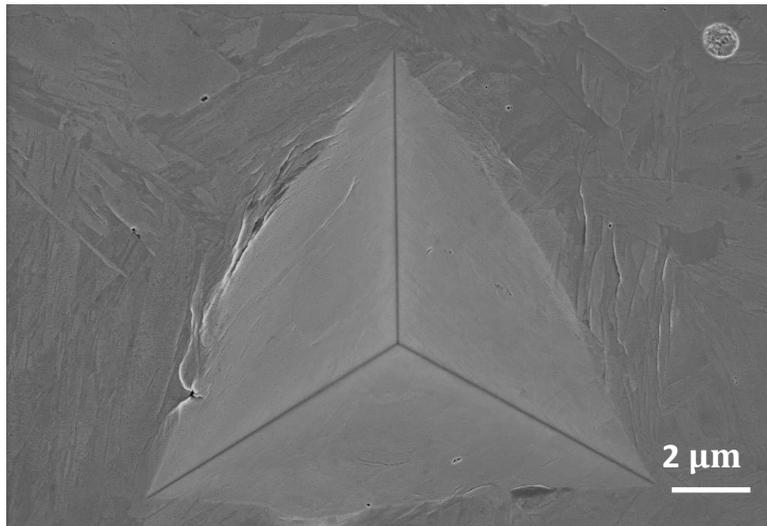
Segregation of B, Si, and C at the PAGB is known to affect the cohesive strength of the interface.

# PROJECT ACTIVITIES

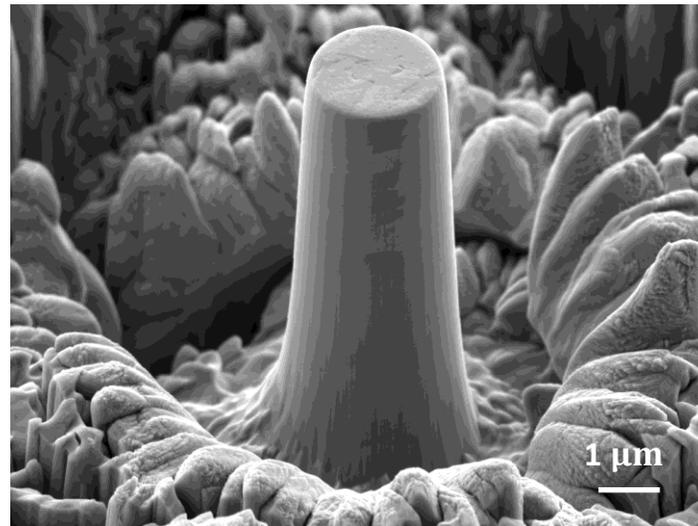
Insights into residual influence using micromechanics



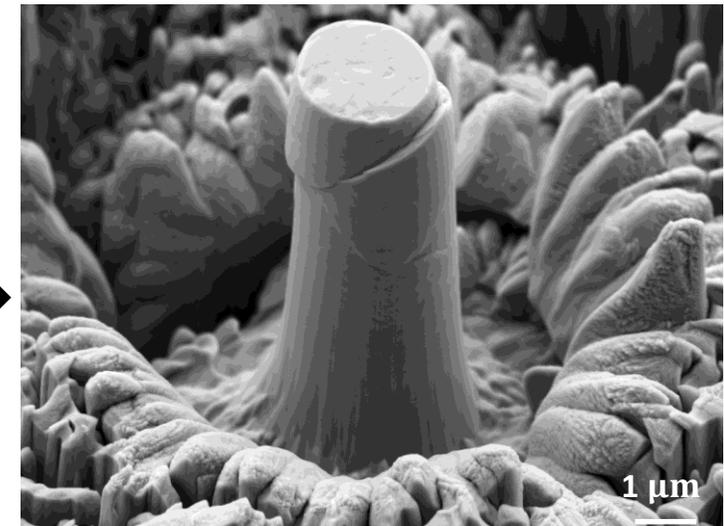
Nanoindentation



Micropillar compression



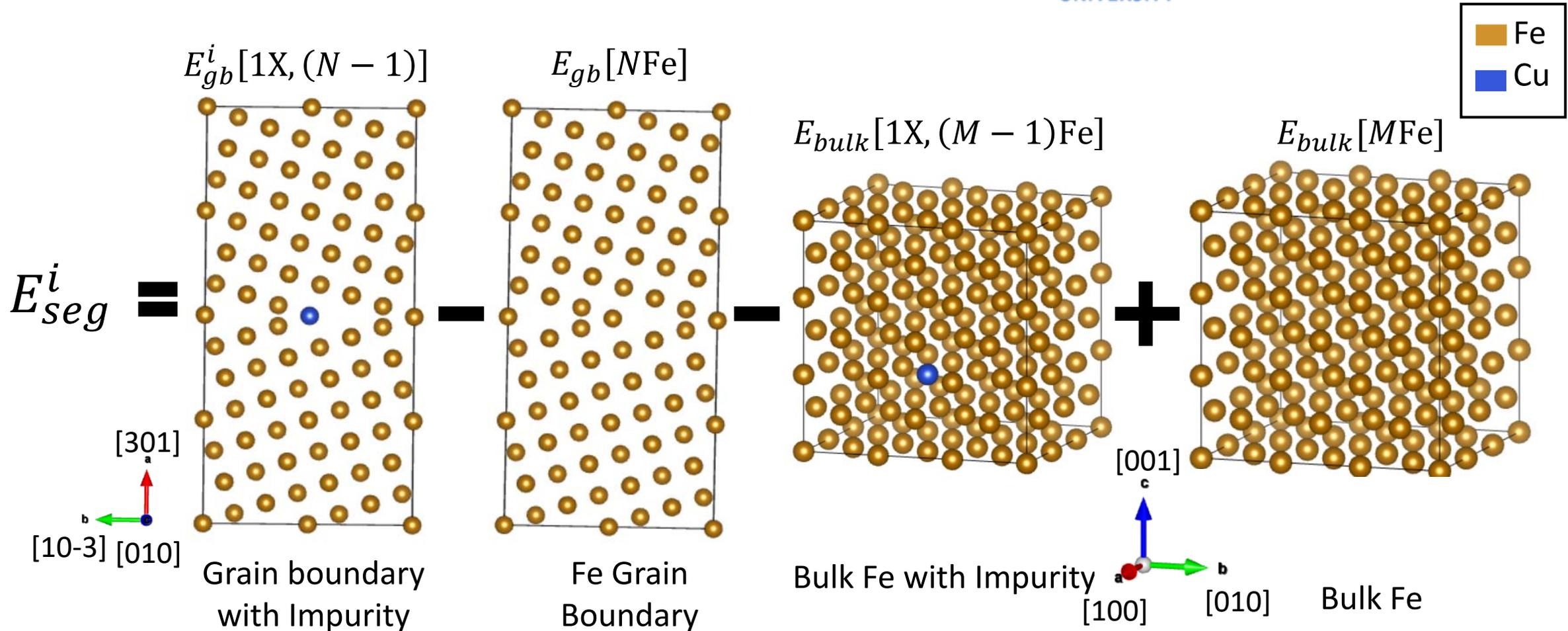
Before test



After test

# PROJECT ACTIVITIES

## Atomistic models: residual element segregation



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