RecHycle

HBI C-Flex online workshop

25/02/2025

RecHycle - Recycling (renewable) hydrogen for climate neutrality has received funding from the European Union's Horizon Europe research and innovation programme call HORIZON-CL4-2021-TWIN-TRANSITION-01-22, under grant agreement no. 101058692.

Agenda

01. Video introduction

02. Roadmap ArcelorMittal Belgium

03. RecHycle overview

04. Research topics

05. Status demonstration

06. What's next?

Funded by the European Union

VLAIO

RECHYCLE

RecHycle has received funding from the European Unions's Horizon Europe - Clean Steel partnership programme (adjustment of steel process production to prepare for the transition towards climate neutrality). Project no: 101058692.

ArcelorMittal Belgium has secured funding from various sources, including the Horizon Europe programme. The Flemish government also provided support through VLAIO, the Flemish Agency for Innovation and Entrepreneurship.

Funded by the European Union

VLAIO

RECHYCLE

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The Sustainable Path

Vision: Making ArcelorMittal Belgium Ghent site an integrated carbon-neutral steel plant

2030 GOAL

35% CO_2 reduction compared to 2018

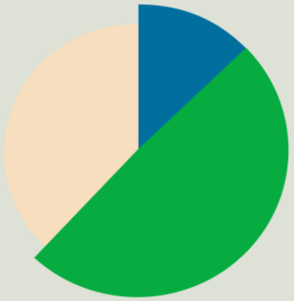
RecHycle sums to ArcelorMittal's decarbonisation efforts by investigating the use of (green) hydrogen to replace coking coal and pulverised coal

Roadmap ArcelorMittal Belgium

Efficiency

Heat, Energy

Green Primary



Electrification

Gas & H_2

Smart Carbon

Circularity

CCU

CCS

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Grant agreement no: 101058692

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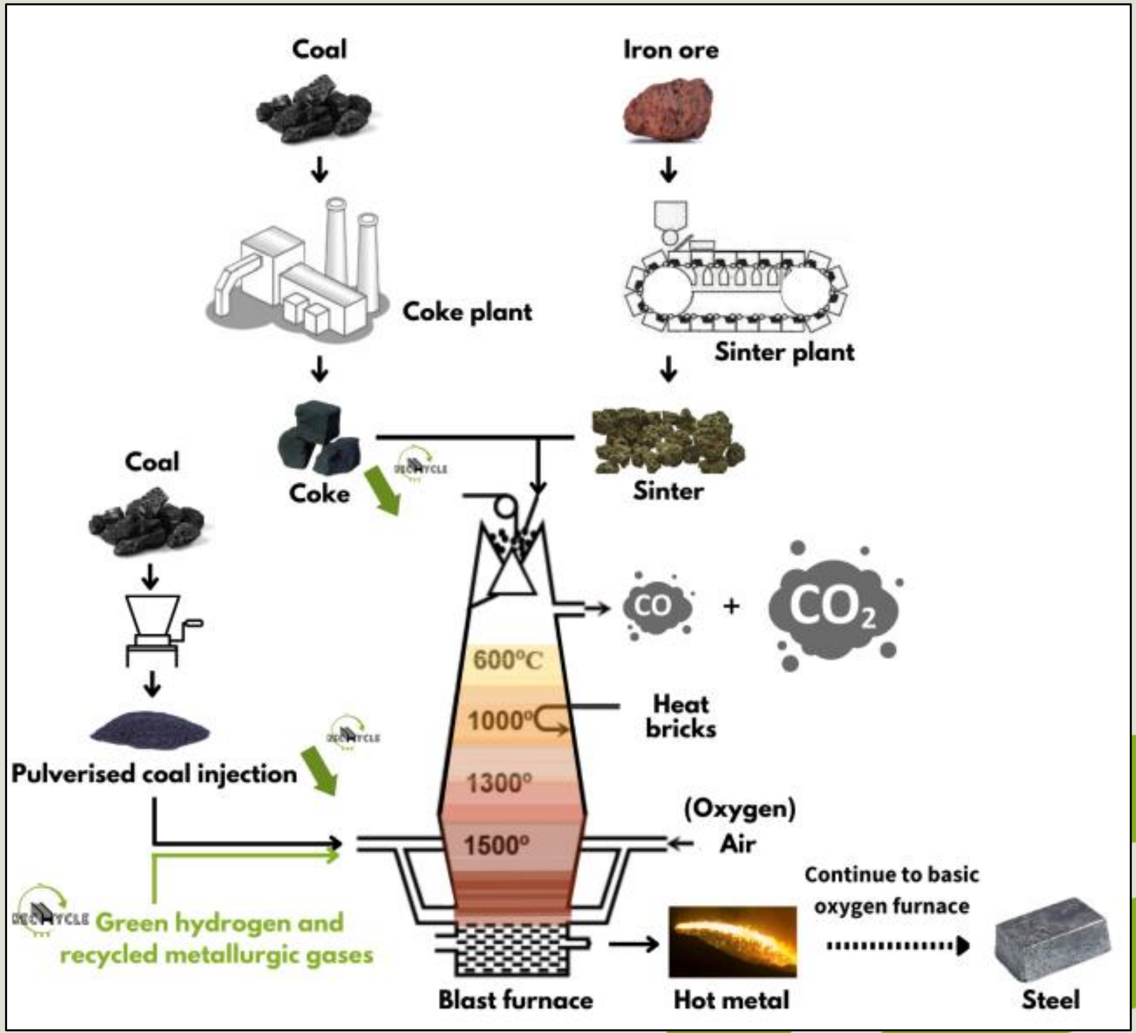
Project overview and description

- RecHycle investigates the use of (green) hydrogen and recycled metallurgical gases in steelmaking to replace coke and pulverised coal.

- **$Fe_2O_3 + 3\ H_2 \rightarrow 2\ Fe + 3\ H_2O$**

- Ambitions of the project:
  - Outperform SoA hydrogen rich gas injection in steelmaking.
  - Demonstrate a gas hub mixing different gas feeds and valorising them in the steel industry.
  - Provide a knowledge base on hydrogen impact on materials and components
  - Dynamic optimization of gas mixtures and flows
  - Develop a new ceramic tuyere.
  - Reduce the carbon footprint by valorising and recycling waste gases.
  - **Reduce 200 kton CO_2 per year**

https://www.rechycle.eu/



Consortium

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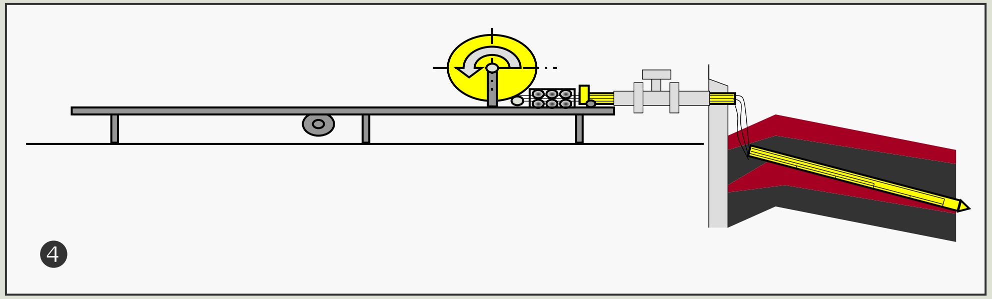
Agenda

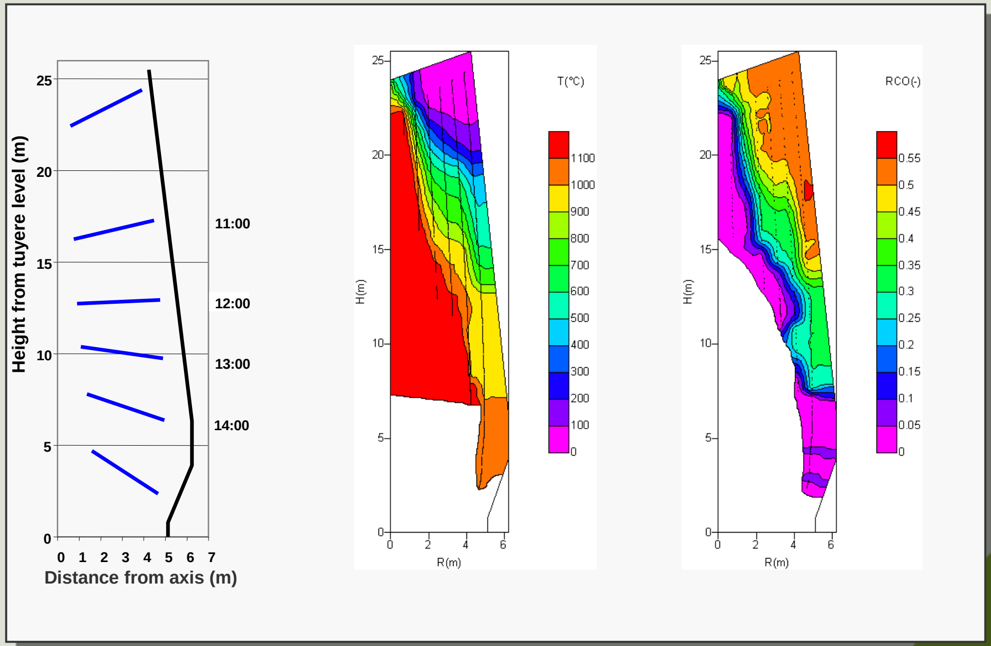
AM Maizière Research Center: Modelling Blast Furnace operation with H2-rich gases Industrial trials

ArcelorMittal

- Trials will be done at the blast furnace for process characterization and model validation
- A Multi-Point Vertical Probe (MPVP) will be used to measure temperature and gas composition all along the blast furnace shaft.
- The outputs of those measurements will help to understand the impact of H_2 in the reduction and melting zones of the BF.
- Those measurements also give an unique opportunity to validate our models with a detailed description of the thermal and chemical conditions inside the BF

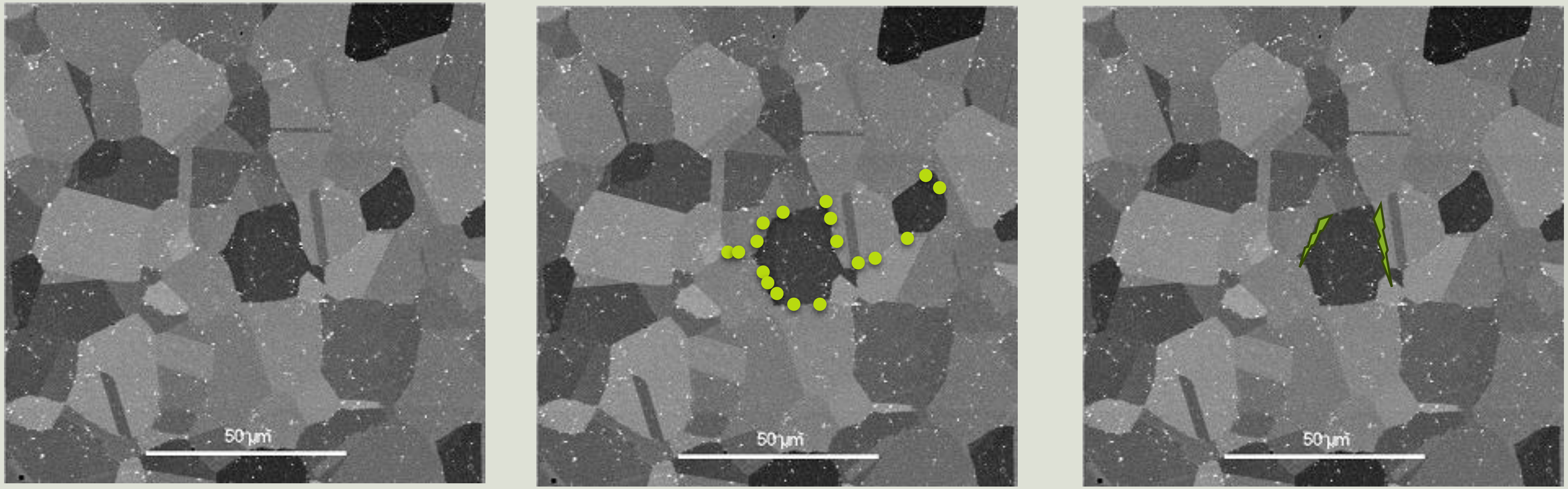


Schematic of MPVP insertion into Furnace



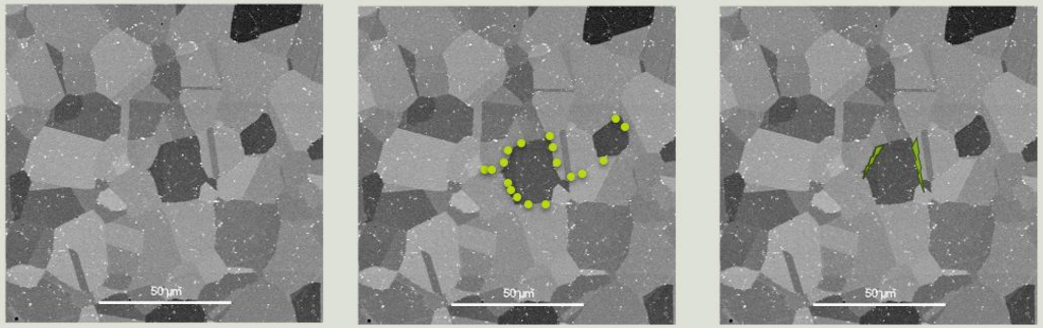
Thermal and Chemical Map Obtained from MPVP

JOANNEUM RESEARCH (JOA): H_2 embrittlement
– Presentation of the problem



Before the Hydrogenisation *After the Hydrogenisation* *In exploitation*

JOA - H_2 embrittlement



Before the Hydrogenisation *After the Hydrogenisation* *In exploitation*

Strategy of work:

- **Analysis of the components exposed to hydrogen** and determination of the level of impact of hydrogen on their proper functioning during the steelmaking process.
- **Screening of the materials used to make these components** and the literature review of the impact of hydrogen to their properties, in terms of embrittlement.
- **Material testing campaign to determine this effect physically and chemically**.
    1. Exposure of the material to Hydrogen at room temperature
    2. Exposure of the material to Hydrogen at elevated temperature
    3. Mechanical testing of the exposed vs. non-exposed material – to evaluate comparatively the effect of embrittlement, if any.
    4. Metallurgical observations – to spot the reasons of embrittlement, if appears, in terms of what metallurgical transformation of the material takes place to create the embrittlement.
- **Proposition of measures to improve the component resistance to embrittlement**, by proposition of protective measures (e.g., coatings) and/or other materials.

H2 embrittlement

Material testing campaign:

- ➢ Exposure of the material to Hydrogen at room temperature;
- ➢ Exposure of the material to Hydrogen at elevated temperature;
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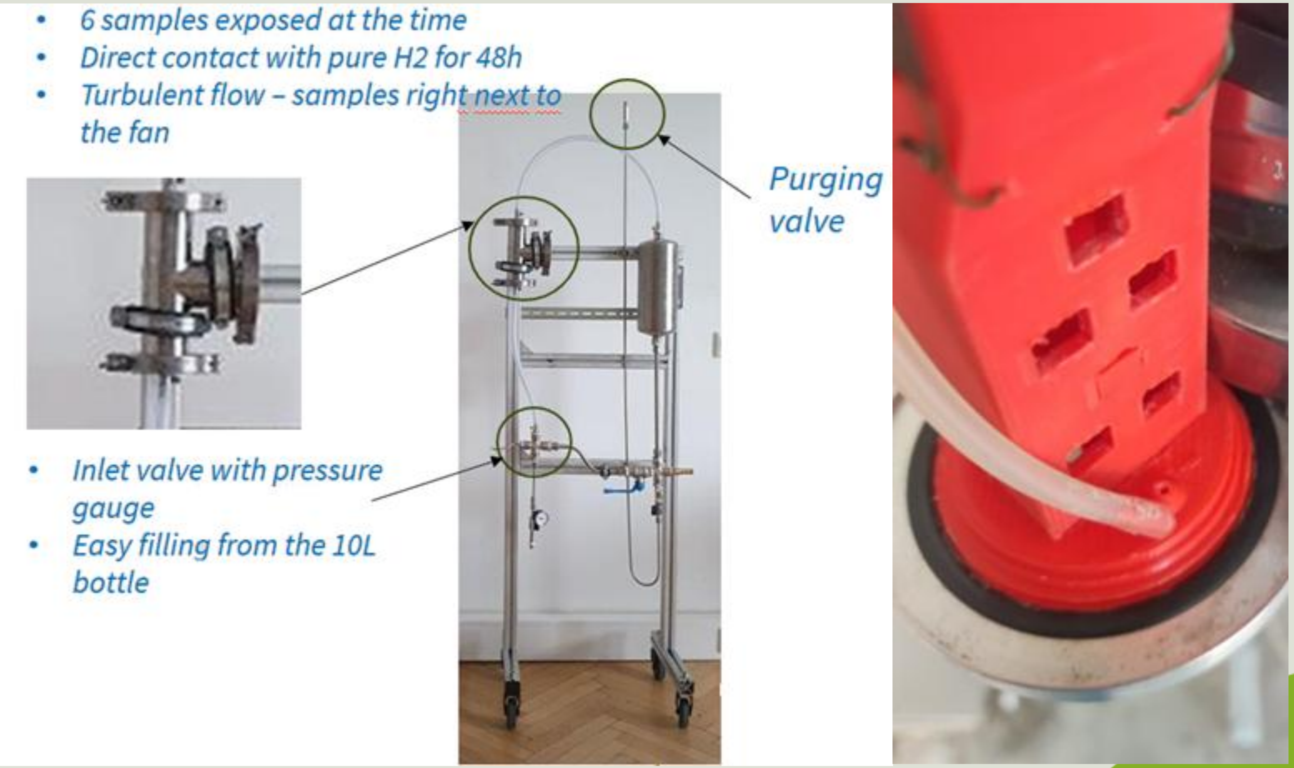

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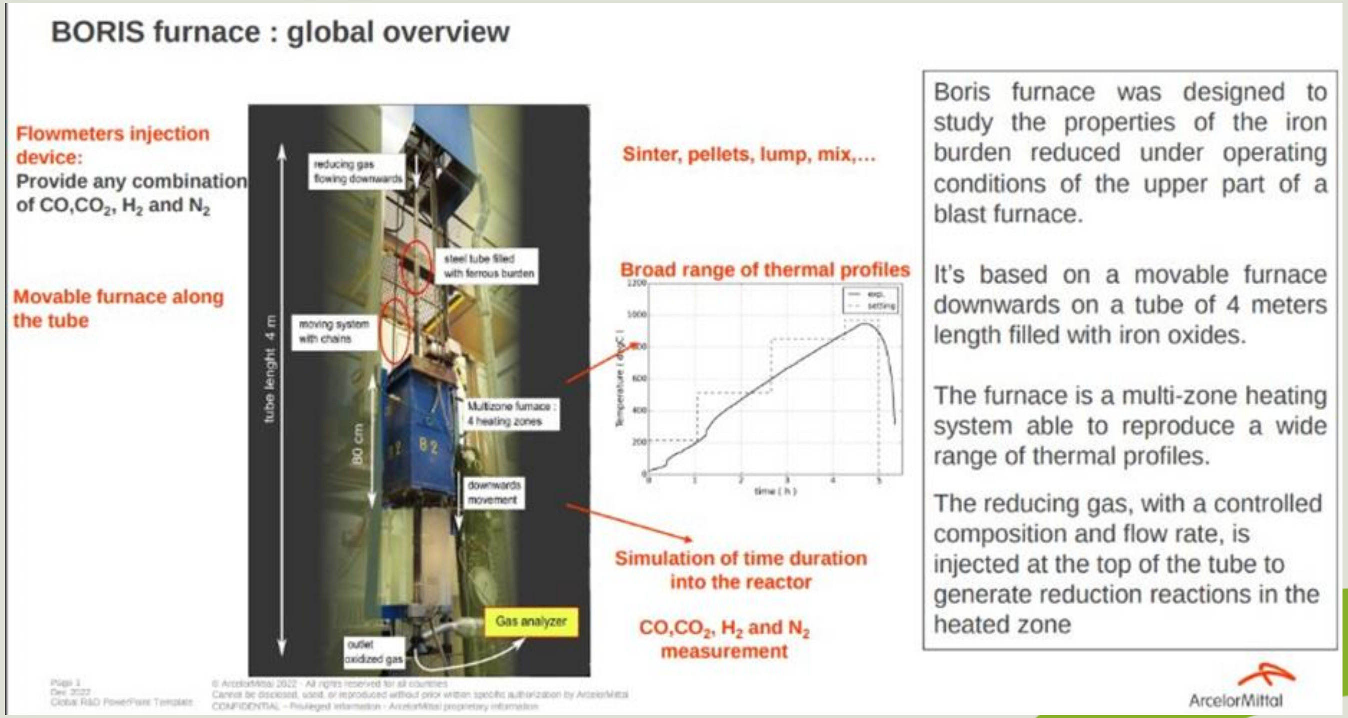

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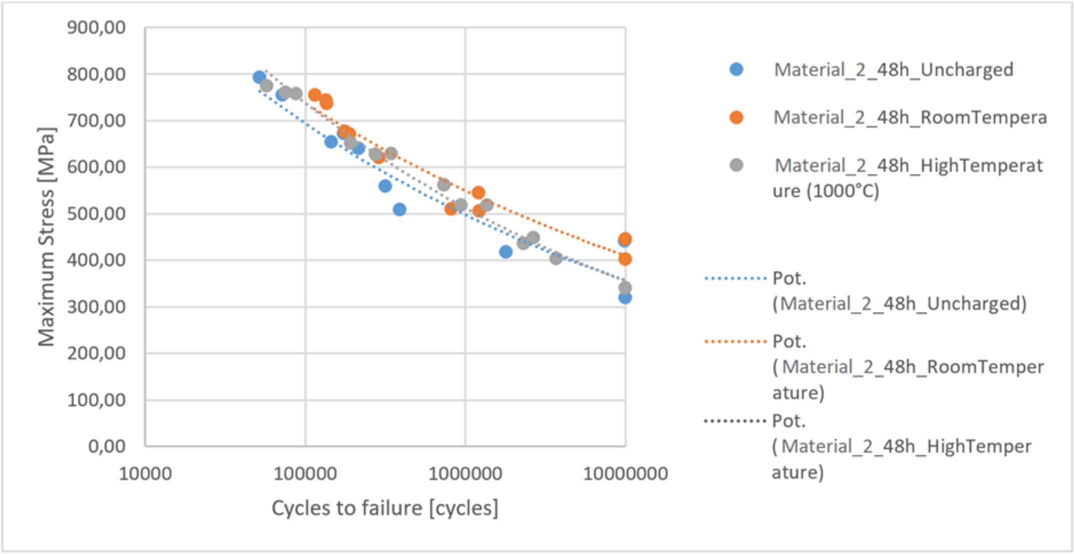
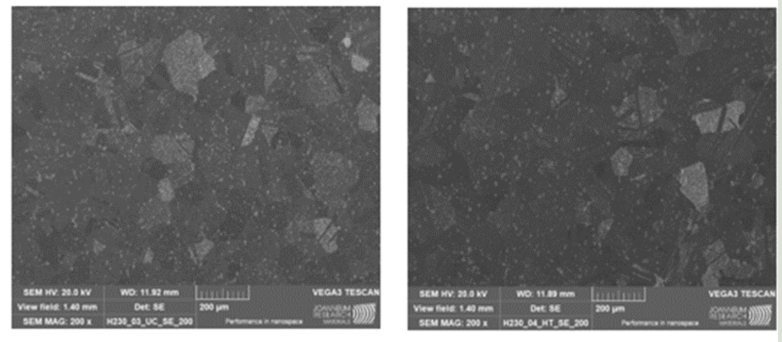
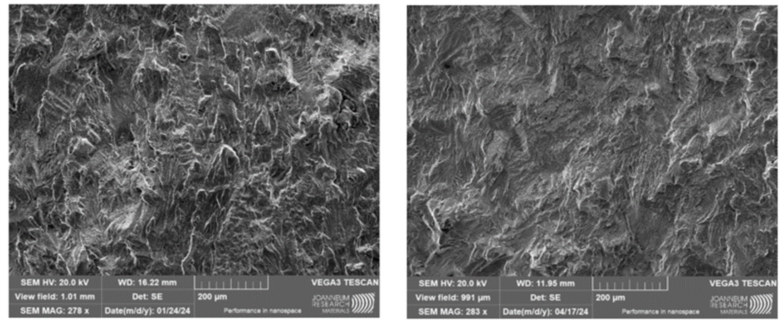
JOA - H_2 embrittlement

Main conclusions:

- After charging and testing, neither of materials showed relevant embrittlement and microstructural change on both room and high temperature, which indicates their resistance to the phenomena of cracking or hydride formation.



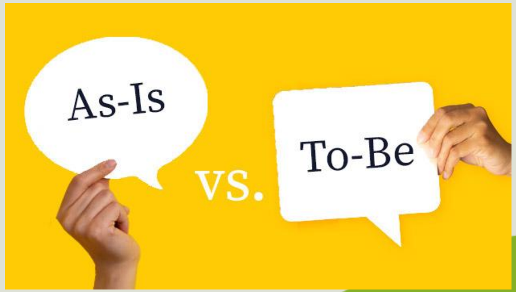




Università Politecnica Della Marche – LCA

Scope of the LCA:

- Defining the object of the assessment (Function, Functional Unit and Reference Flow)
- System boundaries and completeness requirements
- Life Cycle Inventory modelling framework
- Selecting the geographical, temporal and technological boundaries and settings of the study
- Selecting the assessment parameters (preparation of the basis for the impact assessment)



Reference flow: One ton of hot metal produced via the systems AS-IS versus TO-BE

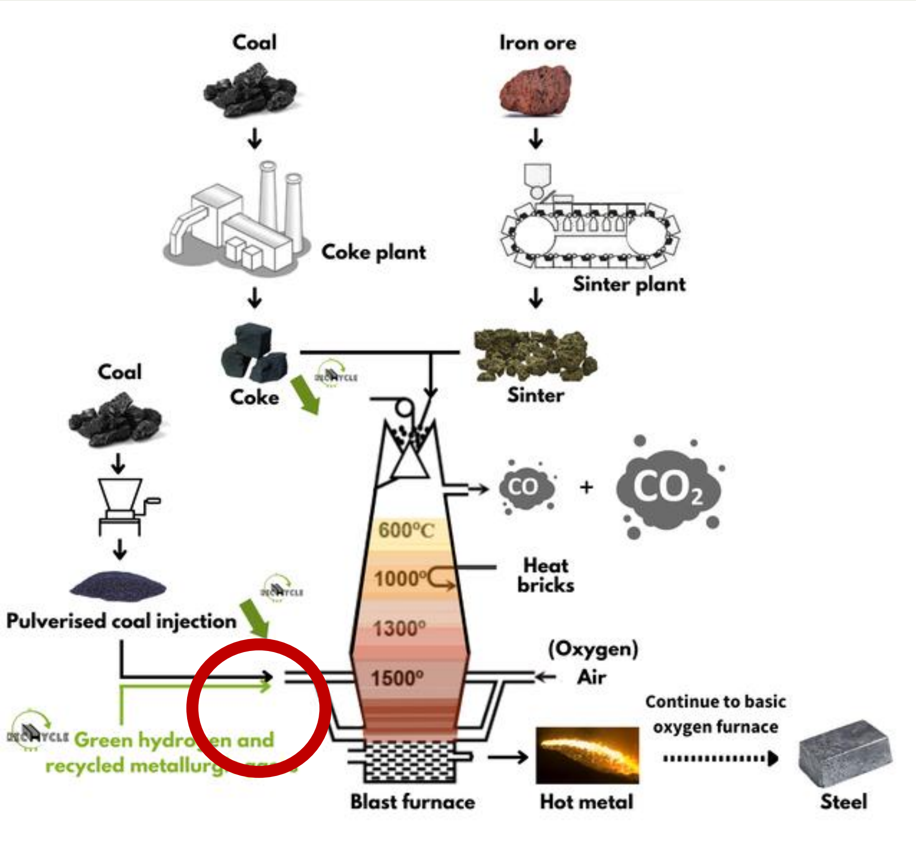
Results: AS-IS and TO-BE scenarios compared through the Life Cycle Assessment → changes introduced by the new infrastructure

CNRS & IRT: Ceramic Matrix Composites

Centre National de la Recherche Scientifique

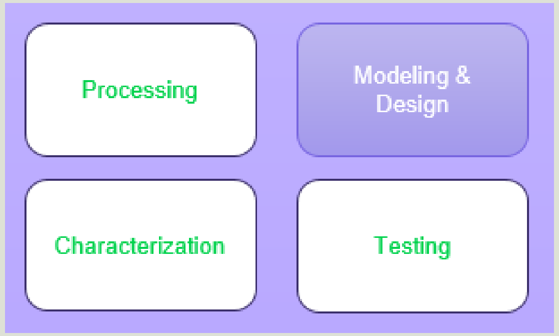
Joint Objectives

Propose and manufacture a CMC insert for the tuyere :
Choice of the material, modelling, characterization

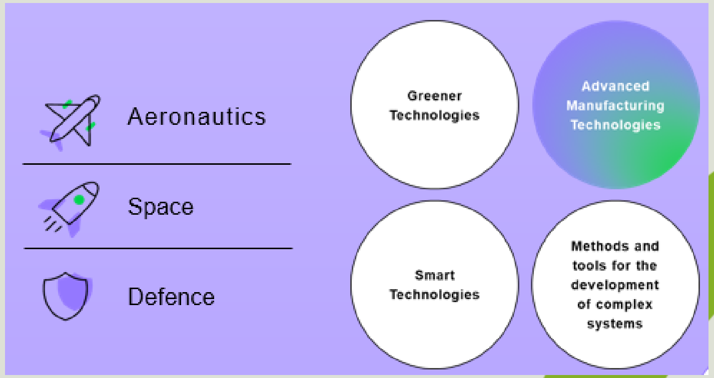


Arcel

CNRS - LCTS is a joint research unit dedicated to all basic science aspects on thermostructural composites



IRT SE is a collaborative and integrated technological research center bridging the public research to the industrial one.



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Status demonstration

June 2022	Oct 2024	Q2-Q3 2025	Nov 2026
• Start of the project	• Engineering close to completion • Construction ongoing	• First demonstration	• End of project

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- AMB: focus on the first demonstration and in parallel source hydrogen for the future
- JOA will publish a paper on hydrogen embrittlement
- AMMR will perform the MPVP trials
- CNRS and IRT will design, construct and test a CMC designed for the tuyere at AM Ghent
- UPM will continue working on the TO-BE scenario for the LCA with data from the demonstration

RecHycle

Thank you!

Any questions?

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