# SMARTWELD - 101112414


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| **Start date:** | July, 2023 |
| **Duration: (optional)** | 42 Months |

*Keywords:* ***Hybrid Welding; Pipelines; Online Quality Monitoring; Digital Twin; Ultra-High Strength Steels; Laser Welding; Plasma Welding.***


## Motivation

The SMARTWELD project aims to advance eco-friendly welding processes to align with the European Green Deal goals. To contribute to the goal of a 55% reduction in steel industry $CO_2$ emissions by 2030, the project focuses on combining material processing efficiency and hydrogen transition, targeting a 48% decrease in direct emissions. The key role in this strategy is attributed to innovative welding processes, particularly hybrid plasma and electric arc welding (PAW+MAG) and hybrid laser beam and electric arc welding (LBW+MAG) for pipeline welding. This system is anticipated to reduce machining time by 15%, filler material/flux usage by 25%, energy and shielding gas consumption by 15%, while improving productivity by 33% and decreasing repairing activities and residual stresses by 15%. Comprising new robotized welding technologies, digital-twin-assisted quality monitoring, and a predictive tool, this system aims to deliver efficient, eco-friendly welding. Validation of these technologies at TRL5 within the project timeframe is planned, with a market launch anticipated five years after project completion. Initially focusing on a specific business case (UHSS pipes), the project will then assess the transferability of results to other critical welding areas such as hydrogen steels and structural steels.

## Welding Processes

**HYBRID WELDING TECHNOLOGIES.** The starting point of hybrid welding technologies is to combine laser or plasma welding technologies with standard MAG technology in an automated/robotic fashion.

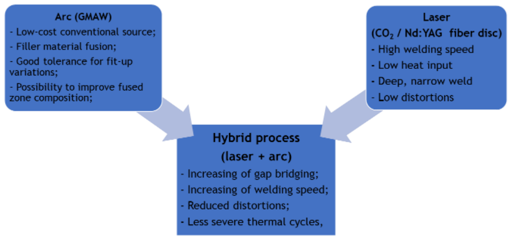


*Figure 1: Hybrid configuration.*

**PAW (Plasma Arc Welding) used with PulsedARC and transfer mode**. It is characterized by low purchase cost, and reliable technology. The possibility to produce narrow and deep penetration is acknowledged; the application of Pulsed Arc AC/DC arc supply in the technique improves penetration and stability of the process. The use of PAW Pulsed Arc in the pipeline girth welding activity is not diffused or commercially adopted so it can be considered, to all extents, a novel technology/application in this sector. **LBW (Laser Beam Welding)**. Laser welding is still considered a novel technology although it is widely used in many fields of fabrication; basic restrictions of laser welding technologies are the high cost of laser apparatus and automated or robotic stands, but the development of new laser sources, the increasing efficiency and lowering cost per kW occurring in the last decade (i.e. 50 k€/kW to 15 k€/kW), makes this technology very interesting for welding application of high thickness and oil & gas activities especially in automation systems. Selection of the process parameters is dependent on: Thickness,

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Material, Joint type, Gap, Production requirements and Target of productivity.

## PROJECT OBJECTIVES

The general objective of the SMARTWELD project is to contribute to the mitigation strategies of the steel sector to meet the 2050 global energy and climate goals. This will be achieved by developing, validating, and diffusing a smart integrated welding system – constituted by:

1. New automated hybrid welding technologies;
2. Digital-twin-assisted online quality monitoring systems;
3. A predictive tool providing efficient, eco-friendly welding processes.

## CONTRIBUTIONS LABO SOETE

Within this project, Laboratory Soete (LS) is contributing to the definition an design of the materials and welding. In the integration and validation, LS is set to embark on a comprehensive full-scale characterization process. A complete analysis in terms of fracture and fatigue performance is carried out.

**Fracture performance** will be dedicated to:

**(a) Impact tests by Charpy V-notched specimens;**

*Figure 2: Charpy V-notched specimens.*

**(b) fracture toughness curves on SENT specimens;**

The test is performed in accordance with standards BS 7448 and ASTM E1820-18.

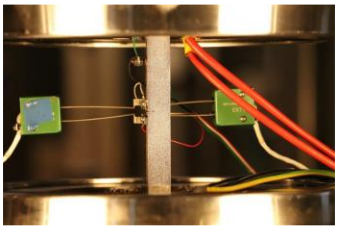

*Figure 3: SENT testing of weld showing porosity*

**(c) Curved Wide Plate (CWP) tests on a dedicated test rig.**

Tests will be conducted following the UGent guidelines for CWP testing.

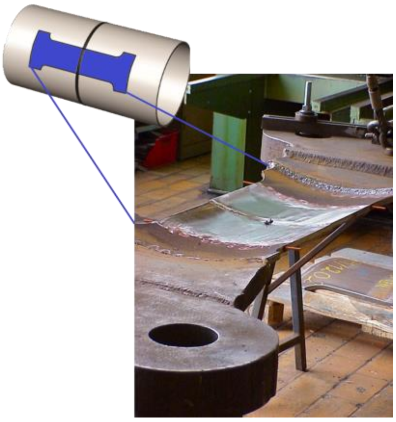

*Figure 4: Curved Wide Plate test specimen.*

*Figure 5: Dedicated test rig for CWP.*

**Fatigue performance:** Full-thickness strip specimens will be extracted from full-scale joints according to DNVGL-RP-C203 and will be characterised via tensile fatigue, R-ratio of 0.1. For two materials, three welding methods and one thickness value.

*Figure 6: Fatigue testing specimen.*

Moreover, LS is leading a WP related to Communication, Dissemination, and Exploitation.


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