Title : Understanding of the localized corrosion mechanisms of welded Lean Duplex 2202 - Identification of the weak points and improvement of the process

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Collaboration: APERAM

Funding: CIFRE

1. Introduction

Aperam is a leading producer of stainless steels and this PhD is directly linked to the economical development of high performance stainless steel. The production of high performances stainless steel with a control of the raw material cost (limiting the Ni content) lead to the development of Duplex stainless steel. This grade family correspond to a dual phase (austenite / ferrite) structure. This particularity permit to bring good mechanical properties and corrosion resistance (similar to 300 serie). Therefor, desalination plant application is very promising for near future economic developments, especially for the Lean Duplex 2202 (DX2202) which can bring similar properties than AISI 316L.

Most applications for DX2202 require a welding operation. During welding the phase balance of the microstructure evolved. The microstructure in heat affected zone is more ferritic and, due to rapid cooling, phase compositions are out of equilibrium. Moreover, precipitations phenomena occur, more particularly chromium nitrides precipitates in the nitrogen saturated ferrite. This out of equilibrium microstructure behaves differently from the non welded metal and its properties vary with welding conditions and chemical composition.

2. The Project

Considering all the background about DX2202, the welded area is identified as a key point to manage to ensure the robustness of installations. The welding processes are complex and induced strong modification of the microstructure in terms of grain size, phase fraction and composition, secondary phase precipitation, etc. All of these modifications can have a strong effect on the localized corrosion mechanism both for initiation and propagation.

The aim of this PhD is to determine the nature of the weak points leading to the localized corrosion and to find a way to limit the impact of these defects. It should include:

- Simulation of the Heat Affected Zone with rapid thermal treatment, detailed characterization of the microstructure and comparison with real welds;

- Characterization of the surface modification during welding in terms of structure and composition (SEM, DRX, XPS)
- Determination of the electrochemical behavior at macroscopic and microscopic scale;
- Improvement of pitting resistance through modifications of the grade composition and/or of the welding process.

This project is very challenging. It will happen in the frontier between metallurgy, surface characterization, corrosion and process.

This work happens in the frame of a close collaboration between ICB and APERAM Company. The PhD student will work between ICB Dijon - around 70 % of the time - and will have also to carry out experiments and characterization campaigns at Aperam Research Center (located in Isbergues, Lille region). The balance can evolve according to the project orientation.

3. Applicant Background

Applicants must hold a master in metallic materials (or equivalent), with appreciated knowledge on surface characterization, electrochemistry or corrosion. The applicant must be self-driven and highly motivated. He/she must exhibit human skills to work within a motivated team of technicians and researchers.
English is mandatory, French is a big plus.

4. Application

Please send a resume + motivation letter + references to the e-mail address below : laura.vallat@aperam.com