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Measurement of diffusible hydrogen in metallic materials - HELIOS 4 HOT PROBE method

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CEN-CENELEC Management Centre: Rue de la Science 23, B-1040 Brussels

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European Foreword

This CEN Workshop Agreement (CWA 17794:2021) has been developed in accordance with the CEN-CENELEC Guide 29 "CEN/CENELEC Workshop Agreements – A rapid prototyping to standardization" and with the relevant provisions of CEN/CENELEC Internal Regulations – Part 2. It was approved by a Workshop of representatives of interested parties on 2021-05-31, the constitution of which was supported by CEN following the public call for participation made on 2020-10-26. However, this CEN Workshop Agreement does not necessarily include all relevant stakeholders.

The final text of this CEN Workshop Agreement was provided to CEN for publication on 2021-07-27.

This CEN Workshop Agreement is based on the results of the FormPlanet research project, which received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement Nº 814517.

The following organizations and individuals developed and approved this CEN Workshop Agreement:

- EURECAT, Spain, Ms. Begoña Casas (Chairperson), Mr. Eduard Piqueras, Mr. David Frómeta, Mr. Daniel Casellas, Ms. Montserrat Vilaseca, Mr. Toni Lara, Ms. Sílvia Molas, Mr. Sergi Parareda, Ms. Laura Grifé, Mr. Amadeu Concustell
- UNE, Spain, Mr. Javier López-Quiles (Secretary)
- LETOMEC S.R.L, Italy, (CWA draft leadership), Ms. Linda Bacchi, Ms. Serena Corsinovi, Ms. Paola Bonfanti
- ARCELORMITTAL MAIZIERES RESEARCH, France, Mr. Thomas Dieudonné, Mr. Thierry Sturel
- DIN, Germany, Mr. Jens Riedel
- UNIPI, Italy, Mr. Renzo Valentini, Mr. Bernardo Disma Monelli, Ms. Randa Anis Ishack
- ZWICKROELL, Germany, Mr. Eduard Schenuit, Mr. Aleksander Koprivc

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Introduction

HELIOS 4 HOT PROBE test method was developed as a consequence of the use of advanced high strenght steels with increased mechanical properties that present awsome performance but can be susceptible to hydrogen emebrittlement phenomenon. Diffusible hydrogen may be absorbed in several steps of component production from steel making to part manufacturing, and it is fundamental to identify anomalous hydrogen content that may potentially lead to failure.

At the state of the art, at the best of the knowledge of the authors of this document, none non destructive method for industrial monitoring of hydrogen absorption and consequently assess the risk of hydrogen induced delayed fracture, has already been developed for bare and coated metals.

The present test method was developed within the framework of FormPlanet Horizon 2020 project to make the first step toward industrial online diffusible hydrogen monitoring and assess sheet metal part quality directly during manufacturing with a non-destructive methodology. We made a demonstrator on chassis for automotive industry, but also geometries as coils or any other components are allowed.

The research activity was focused on the optimization of equipment operation as well as the development and validation of test method.

In particular “Task Industrial on-line deiffusible H measurements” was carried out to improve the equipment functionality, instrument has been redesigned, both hardware and software, in order to reach the Industry 4.0 objectives, as well as sensor calibration.

Later in Task “Transport BiW or chassis part/AHSS” the device was used for industrial demonstrator of the HELIOS 4 HOT PROBE measurement method on high strength AlSi coated Press hardening Boron steel chassis reinforcement components. Test will be part of the final test bed service catalogue.

Test method falls within the patent EP2912452 B1 rights.

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1 Scope

This CWA provides a set of guidelines for the measurement of diffusible hydrogen content in steel sheets, that can be susceptible to hydrogen embrittlement phenomenon. Hydrogen pick up can take place in several processes from steel production, through part manufacturing, till the service life of component.

Current risk assessment methods consists in complicated laboratory tests that involve time consuming sample preparation and long test duration. These procedure are not suitable for industrial monitoring where quick, easy and possibly non-intrusive metodologies are required.

In this framework, the HELIOS 4 HOT PROBE performs non-destructive diffusible hydrogen measuring method at industrial scale, in order to assess the safe operation of high strength steel parts. The innovative technique allows measurements directly on sheet metal coils and parts, to eventually immediately apply corrective actions in case of process out of control, increasing the safety of the final user.

2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

ISO 15724:2001, *Metallic and other inorganic coatings — Electrochemical measurement of diffusible hydrogen in steels — Barnacle electrode method*

ASTM F519-18, *Standard Test Method for Mechanical Hydrogen Embrittlement Evaluation of Plating/Coating Processes and Service Environments*

ASTM F1624-12, *Standard Test Method for Measurement of Hydrogen Embrittlement Threshold in Steel by the Incremental Step Loading Technique*

ASTM G129-00, *Standard Practice for Slow Strain Rate Testing to Evaluate the Susceptibility of Metallic Materials to Environmentally Assisted Cracking*

ASTM STP 962:1988, *Hydrogen Embrittlement: Prevention and Control*

3 Terms, definitions and acronyms

3.1 Terms and definitions

For the purpose of this document, the following terms, definitions and abbreviations apply.

ISO and IEC maintain terminological databases for use in standardization at the following addresses:

— ISO Online browsing platform: available at https://www.iso.org/obp

— IEC Electropedia: available at https://www.electropedia.org/

3.1.1
Advanced high strength steels (AHSS)
Complex, sophisticated materials, with carefully selected chemical compositions and multiphase microstructures resulting from precisely controlled heating and cooling processes. Various strengthening mechanisms, included phase transformation, are employed to achieve improved balance of strength, ductility, toughness, and fatigue properties (Advanced High-Strength Steel (AHSS) Definitions, s.d.).

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