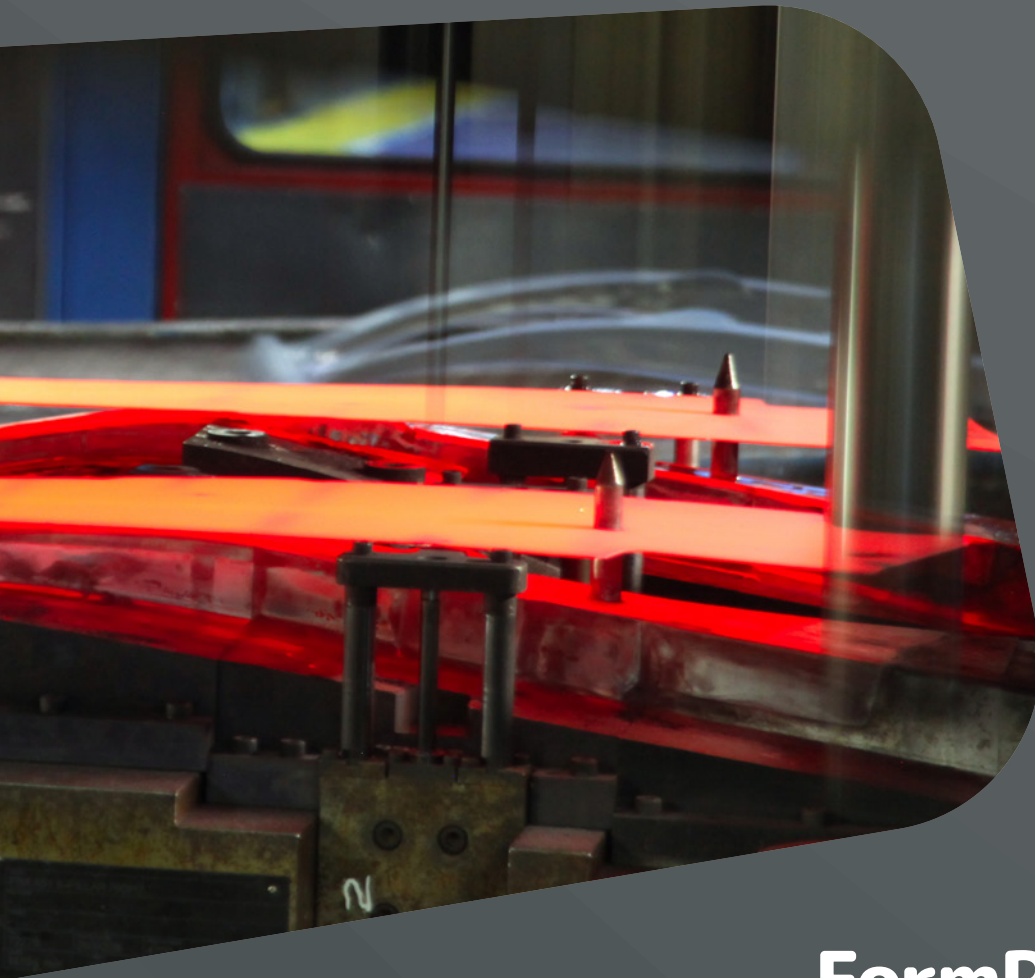


**FORM
PLANET**



FormPlanet Open Innovation Sheet Metal Forming Test Bed

Material characterisation and modelling
services for increasing the competitiveness
of the sheet metal forming industry

FormPlanet Test Bed

One-stop-shop providing integral advanced services to the sheet metal forming industry



Novel testing services to characterise sheet metal properties, predict part performance and prevent production losses, tackling the upcoming challenges in formability and part quality assessment.

What is a Test Bed?

An Open Innovation Test Bed (OITB) is a set of entities, providing common access to physical facilities, capabilities and services required for the development, testing and upscaling of new materials and products to the market.

What is FormPlanet Test Bed?

FormPlanet is a solid and sustainable user-driven European Open Innovation Test Bed (OITB) ecosystem that offers the most innovative sheet metal characterisation, modelling and quality testing services.

FormPlanet Test Bed aims to ease companies' process of technological uptake by offering full service package along all steps of the development of innovative sheet metal forming parts or products.

Benefits

- Access to valuable technological developments**
Compilation in one place of the most advanced and differentiated sheet-metal characterisation and modelling techniques by the industry in the whole value chain.
- Single entry point**
Wide range of services offered altogether by leading materials characterisation organisations accessible across the EU from one place.
- Equality of access and conditions**
Test bed services open to all European companies, especially to SMEs, providing fair and competitive pricing conditions in all regions.
- Service modularity**
We offer the possibility to divide services into smaller modules to access FormPlanet services with lower risk and investment.
- Integral service provision**
FormPlanet full-service package covers each phase of the sheet metal forming value chain with advanced and innovative services.

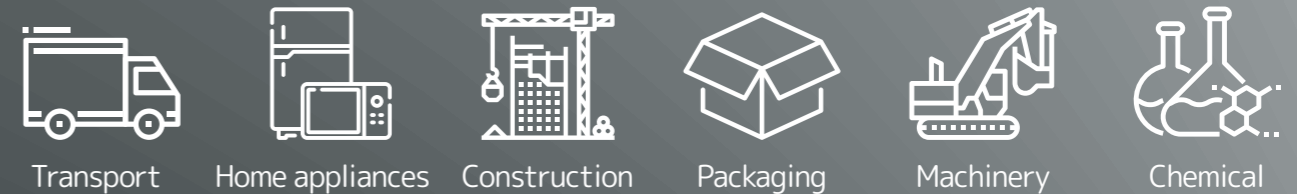
FormPlanet services

FormPlanet offers advanced testing methodologies for more accurate metals characterisation, non-destructive in-process measurements and modelling for high strength sheet materials, addressing processability and quality parts issues in the sheet manufacturing sector.

FormPlanet novel testing techniques limit productivity losses due to forming cracks and inaccurate quality assessment, resulting in a boost of a wide usage of high-strength sheet materials for high-added value products in different applications.

The services comprise three main categories: novel and differentiated metal characterisation tests, in-process control systems and new modelling approaches.

Sectors



A single entry point for accessing the services of leading characterisation organisations with equality of access and conditions

FormPlanet is powered by Eurecat Technology Center, LETOMECC srl and COMTES FHT, three research entities with a solid R&D background in metal forming and sharing a common goal: address the industrial challenges of the sheet metal forming industry.

Powered by:

eurecat

COMTES FHT
Complete Technological Service - Forming, Heat Treatment

LETOMECC



Novel material characterisation services

FormPlanet Test Bed addresses the urgent need for **advanced materials characterisation tests, novel in-process control systems and modelling approaches** to **predict defect formation** at an early design state, as well as **preventing and solving it during industrial manufacturing**, covering the whole value chain.



Sheet material development and production

- Edge cracking and stretch-flangeability
- Micro-mechanical characterisation
- Fracture toughness
- Crashworthiness
- Delayed fracture and H embrittlement
- Fatigue resistance
- Reversible hot/cold rolling

Part and forming process design

- Forming limits evaluation at room
- Modelling of part performance
- Modelling of H embrittlement
- Material data for modelling
- Hot sheet metal forming pilot environment

Components production

- In-process check systems
- In-line part quality assessment

Complementary services

In addition to advanced material characterisation services, FormPlanet offers a **wide range of complementary services** for an integral service provision to the sheet metal forming industry.

- Other material characterisation services
- Consulting services
- Training and knowledge

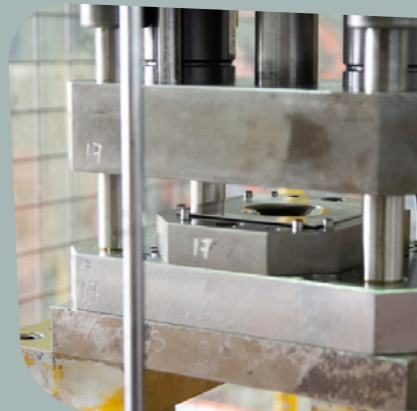
Sheet material development and production

FormPlanet Test Bed provides **new approaches for the evaluation of local damage** (by micromechanics and microtomography), **global and local ductility, delayed fracture, H embrittlement, and crack propagation assessment** (in terms of fracture toughness) with the aim to optimise the development and production of advanced metal sheets.

Edge cracking and stretch-flangeability

Optimised Hole Expansion Test (HET)

A non-standardised HET methodology has been developed through the investigation of the main parameters affecting the hole expansion ratio (HE) as clearance, tool wear, burr position and time from punch to expand. An experimental test configuration developed to objectively **measure crack initiation and propagation** and **obtain reliable and repetitive values of HER**.



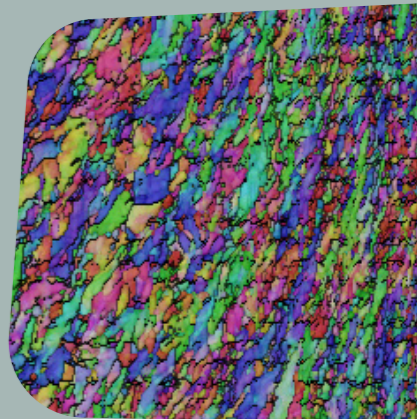
Half Specimen Dome Test (HSDT)

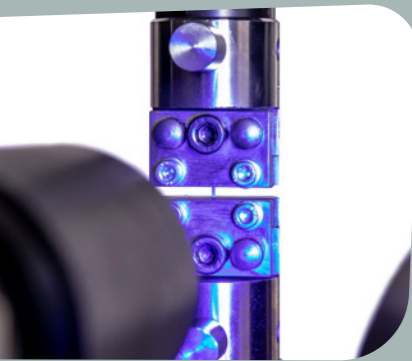
The Half Specimen Dome Test (HSDT) permits to **determine edge cracking behaviour during flanging** in metal sheets. Compared to hole flanging tests, HSDT is a **more time and cost-saving** test for **evaluating edge cracking**. Another advantage is that is unaffected by aspects related to the tools manufacturing for cutting the holes, as the coaxiality between punch and die.



Local damage evaluation of shear edges

Micromechanical techniques as nanoindentation tests and Electron Back-Scatter Diffraction (EBSD) allows to **assess the local damage and properties of sheared areas**. The extension of local damage in sheared areas can be evaluated measuring the Young's modulus variation by a **methodology developed using the nanoindentation technique**. EBSD permits to **evaluate the damage by the quantification of phase transformations**, grain distributions and grain size variations, recrystallised grains and texture due to the cutting and forming processes.



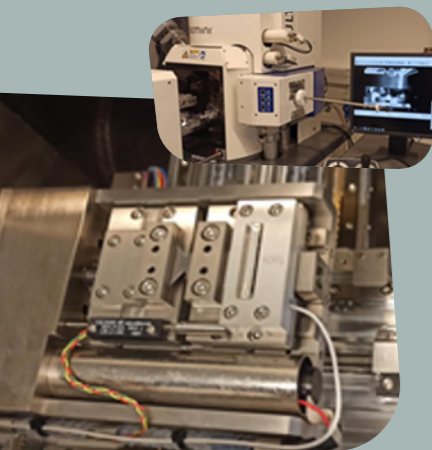


Micro-mechanical characterisation

Micro-tensile tests

Micro-Tensile Tests (MTT) permit to locally **assess basic tensile properties as yield stress, ultimate tensile strength, total elongation, reduction of area and uniform elongation.**

Furthermore, MTT can be used to study **strain rate sensitivity in a wide range of temperatures.** These miniaturised testing techniques can be successfully applied when insufficient volume of material is available, for the development of new alloys, for the evaluation of the local mechanical properties of in-service components and as an input data in numerical simulation for advanced material modelling.



In situ SEM microtesting

In-situ testing (tensile/compression) performed inside a SEM chamber. The in-situ test allows analysing the evolution of the microstructure when the material is subjected to an external load. Service results include the provision of the client with load-displacement or stress-strain curves and SEM images corresponding to each event of the curve. Service applicable for sheet metal up to 3mm. Execution time: 20 hours.



Fracture toughness

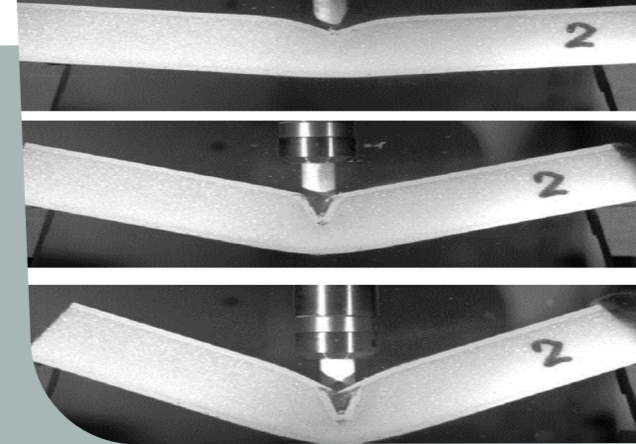
Fracture toughness evaluation of thin metal sheets (1-3 mm of thickness), using mechanically notched or fatigue pre-cracked DENT specimens, and **thick sheets** (>3mm of thickness) by bending tests of fatigue pre-cracked SENB specimens, following fast and affordable methodologies based on the Essential Work of Fracture (EWF). The EWF is the most suitable fracture parameter to rationalise crack-related problems in high-strength metal sheets, such as edge fracture or crash behaviour

Crashworthiness

Dynamic Component Test

The **crash behaviour of components** can be evaluated by two different tests: **dynamic 3-point bending tests on omega profiles and dynamic compression tests on box beams.**

- **Dynamic 3-point bending tests** are performed on an improved setup of Drop Weight Tower with two high speed cameras (assisted by DIC analysis), application of strain gauges on the component and high-speed thermography.
- **Uniaxial compression tests of crash boxes** can be performed, applying 3D DIC for measuring deformations fields around wrinkles and potential cracks.



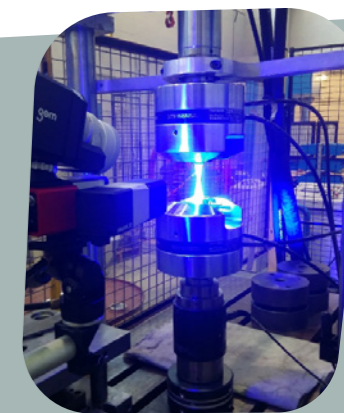
Intrinsic material crashworthiness

A small-scale laboratory test using the Essential Work of Fracture (EWF) methodology for the fracture toughness evaluation at high strain rates allows to successfully **reproduce real crash conditions**, where strain rate abruptly increases. The EWF tests are **conducted in a high-speed tensile testing machine**, combining Digital Image Correlation (DIC) and high-speed photography for the evaluation of the local deformation in the fracture zone.

Fatigue resistance

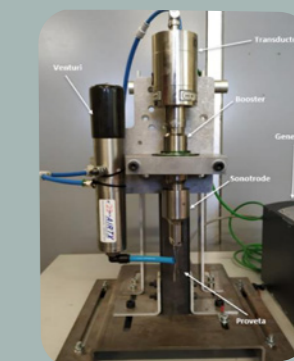
Rapid Fatigue Test

A novel fatigue test based on damage control allows to accurately **determine the fatigue limit of materials** in a fast, cheap and easy way, **using only one specimen.** The methodology consists in monitoring the compliance or displacement evolution during the fatigue test.



Very High Cycle Fatigue test at room temperature

Fatigue life characterisation of thin metal sheets and bulk material in Very High Cycle Regime (from 10.000.000 cycles). Fatigue test with a novel ultrasonic fatigue equipment at 30kHz with different load ratios (mean stress zero - fully reversed - and non-zero). Service results include an assessment of the fatigue strength or fatigue limit estimated through SN curve or calculated with staircase methodology at very high cycle regime.



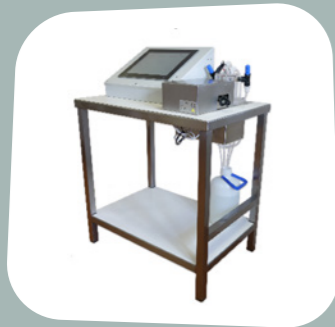
Reversible hot/cold forming

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Delayed fracture and H embrittlement

Diffusion tests

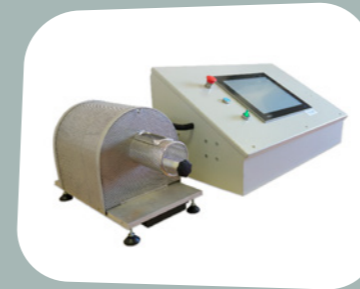


H diffusion testing

Hydrogen permeation test performed by using HELIOS 2 PERMEATION equipment with reference to electrochemical technique described in ASTM G-148.

Tests can be performed on bare or coated sheet metal, at controlled temperature from room temperature up to 50°C.

The test is useful to evaluate the effective hydrogen diffusivity and other hydrogen diffusion related parameters.

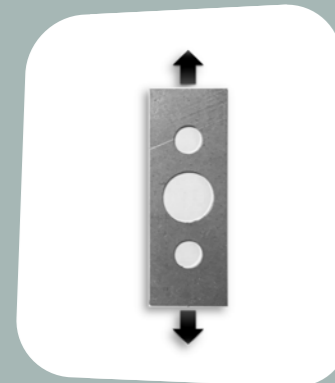


H measurement by hot gas extraction

Measurement of diffusible hydrogen content in metal samples by hot extraction methodology, that consists in heating the sample in order to enhance hydrogen diffusion out of the metal for a quick measurement.

Tests will be executed with HELIOS 3 equipment.

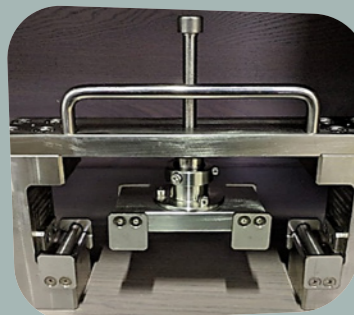
Mechanical tests



Slow Strain Rate Test (SSRT)

Uniaxial tensile slow strain rate tests on notched and/or unnotched specimens based on the guidelines of ASTM F-519/ ASTM G-129 standards. Samples are charged with different diffusible hydrogen contents before testing, and relative average diffusible hydrogen concentration is measured at the end of the test by hot extraction method.

Critical diffusible hydrogen concentration is determined with reference to ASTM STP 962 in correspondence of a reduction of the 30% of a significant material's property in comparison with hydrogen free sample.



Four Point Bending Tests

Incremental step loading four-point bending test is performed as per ASTM F-1624 fully in the elastic range of the material on notched sheet metal specimens. This test is useful to evaluate the critical diffusible hydrogen concentration with reference to ASTM STP 962 in correspondence of a reduction of the 30% of a significant property in comparison with hydrogen free sample. Samples are charged with different diffusible hydrogen contents before testing, and relative average diffusible hydrogen concentration is measured at the end of the test by hot extraction method.

Step load test

This test method is based on standard ASTM F1624 and establishes a procedure to measure the susceptibility of steel to a time-delayed failure due to hydrogen embrittlement. The test consists on increase incrementally the load applied to the sample until its failure.

Stress corrosion cracking evaluation using the constant load test

The constant load test is a method that estimates the hydrogen content threshold at which a steel does not fail due to hydrogen embrittlement under a constant load. The steel is considered not susceptible to hydrogen embrittlement if the failure doesn't appear at 150h or 240h.

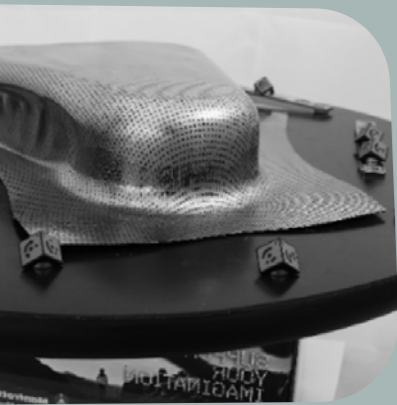
Part and Forming Process Design

For addressing the need to **design components with better performance**, FormPlanet offers specific **tests to better describe sheet formability** and **reproduce part performance in FE codes**, coupling micromechanical characterisation with macroscopic tests.

Forming limits evaluation

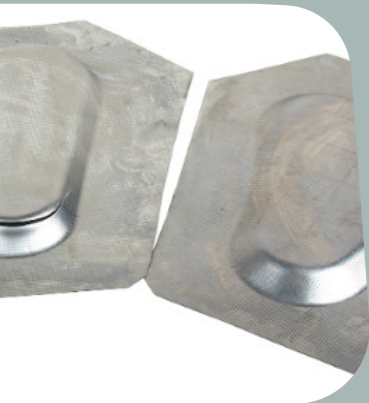
Biaxial tensile test at room temperature

Biaxial tensile tests using optimised cruciform specimens permit the **measurement of linear and non-linear strain paths at room temperature**, at **quasi-static conditions** or at **high deformation rates**. The strain path can be controlled by the displacement of the machine, using DIC system with 3D calibration.



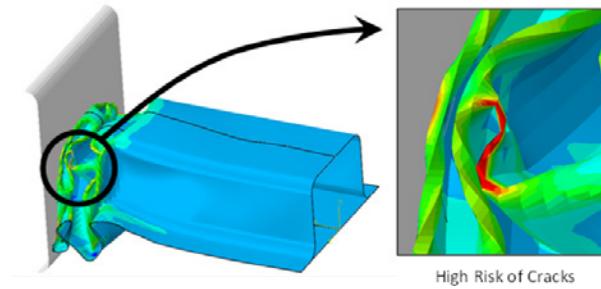
Deep drawing test

This test helps to **predict the critical points in real stamping components** and can be used for the **optimisation of designed die**, **fast acceptance inspection** for new sheet/coil, **FEM verification** and **providing a complex view of formability** (relation between stress and strain state).



Modelling of part performance (crashworthiness)

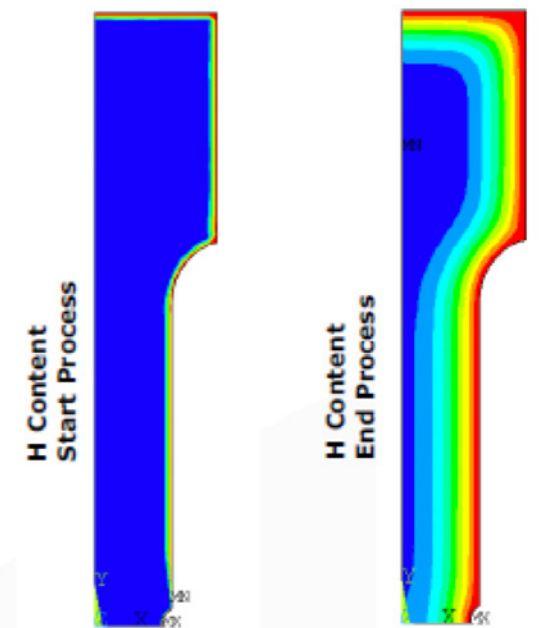
Modelling of crash boxes in terms of absorbed energy, plastic strain distribution and crack formation and propagation. The simulation is performed using the ABAQUS software. The calibrated energy-based failure criterion based on the EWF tests is implemented in the model.



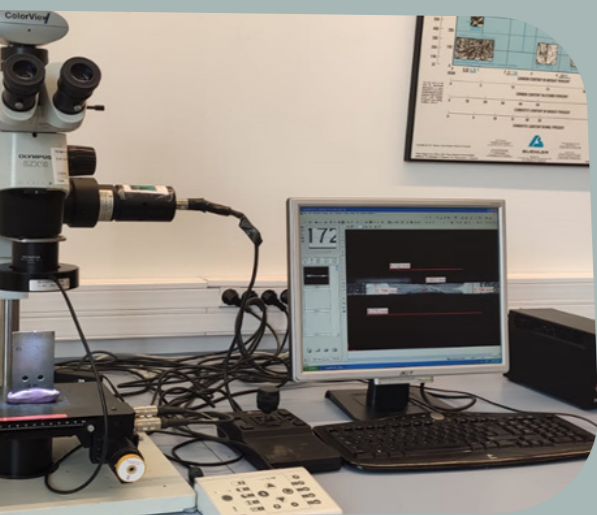
Modelling of H embrittlement

Starting from a given model of the component, accounting the geometry and stress strain distribution map at the end of stamping process, the evaluation of hydrogen diffusion and eventual accumulation over the time can be estimated.

In particular, a coupled diffusion-structural FEM can be used to estimate the hydrogen concentration distribution into structural components to determine the risk for HE.

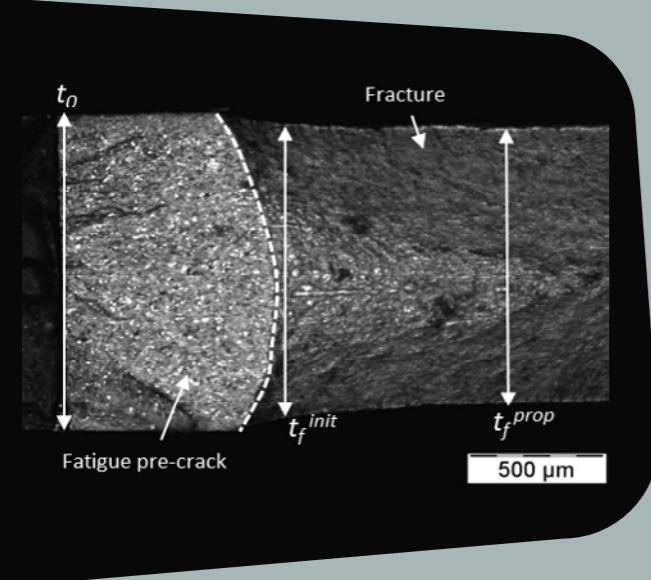


Material data for modelling



Post necking behaviour and fracture strain for anisotropic behaviour

Characterisation of post necking behaviour and fracture strain for anisotropic sheet metals using the stepwise modelling method (SMM). This is a direct method to characterise the post necking plasticity for sheet metals, which is based on full field strain data obtained by tensile testing.



Fracture strain measurements

Improved fracture criteria for **sheet metal forming and failure simulation** (edge cracking, etc.). The method is based on the measurement of local fracture strains on the fracture surface of notched and pre-cracked specimens.

Hot sheet metal forming pilot environment

Hot/warm forming trials on pilot plant, using user-provided test dies (omega shape also available on request) with the aim of demonstrating new processes, generating test samples, trials on lubricants, coatings or material. Service results include a pilot demonstration of a sheet metal forming process, lubricant trials, tool coating and/or treatment trials. The service allows long runs to assess component homogeneity and tool wear.



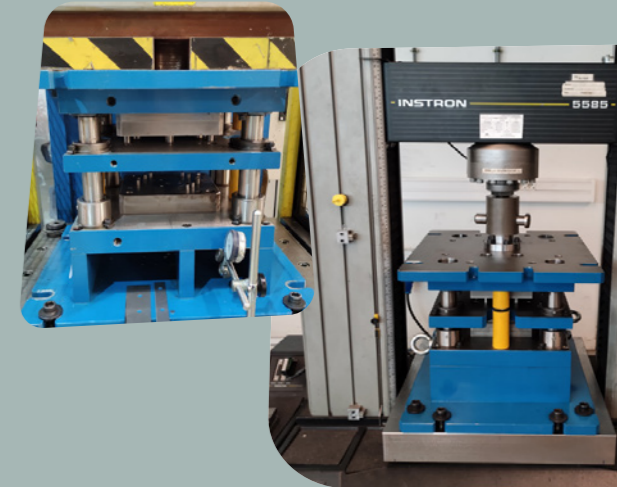
Components production

FormPlanet offers **innovative in-line monitoring techniques** adapted to the metal forming requirements to **assure zero-defects production** as well as **in-situ part inspection techniques** to measure relevant **mechanical properties** and **predict part performance and durability**.

In-process check systems

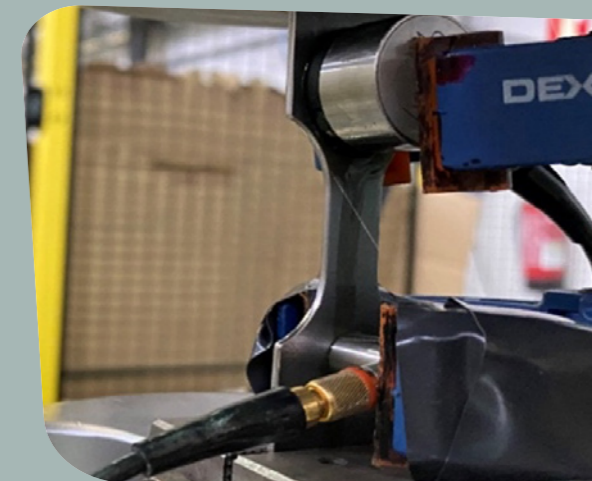
Punching system for quality control of materials

A method based on the instrumentalization of a punch or die tool that allows to detect the parameters required to shear the material. Once the parameters are set by using a calibration step, the system permits to monitor the material quality during the stamping process or even before by doing a fast validation. The system can be easily integrated in any stamping tool without major or relevant modifications.



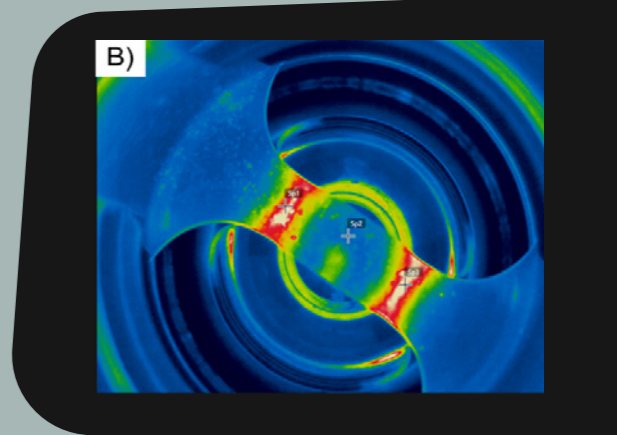
Acoustic emission method for structural health monitoring

Monitoring of structural integrity through the implementation of acoustic emission system. This non-destructive technique permits to locate multiple sensors on a part and monitor its health. The method allows to detect the initiation of cracks in the part once this is cyclically loaded during its utilization phase. The service includes monitoring of part performance, the calibration to detect and locate damage in a part and the relation of the detected damage with microcracks or any form of physical damage.



Advanced thermography for part integrity

Advanced thermography is used for **in-situ detection of surface cracks, thinning and stretching in sheet metal forming**. The localised deformation generates a temperature increment that can be measurable by thermography. Thereby, **sheet thinning, necking and final fracture can be discerned** by tracking the thermal pattern in the metal sheet.

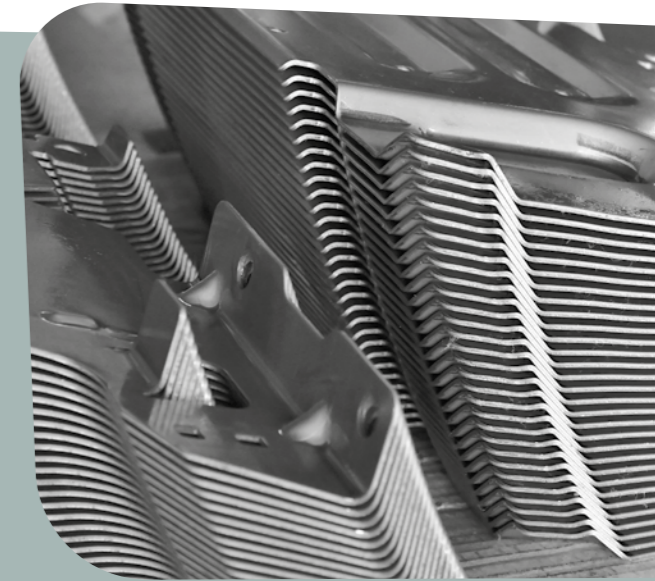


Complementary services

Other material characterisation services

Complementary services are offered by the Test Bed in line with innovative services, offering our clients a full 360° package to meet their needs and ensure that the solutions are optimal for their commercial development.

Some complementary services include: heat treatment, tribometry, fatigue testing, forming or vacuum melting.



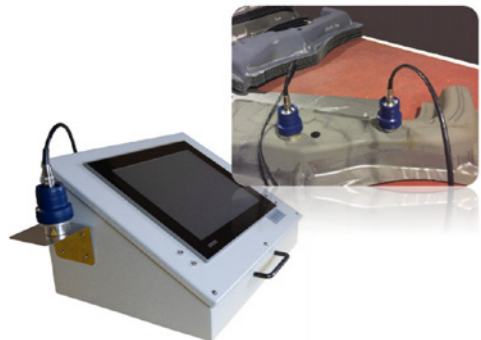
In-line part quality assessment

Industrial on-line diffusible H measurement

After a proper preliminary calibration, HELIOS 4 HOT PROBE equipment is able to perform diffusible hydrogen measurements directly online on sheet metal parts, according to **CWA 17794 2021**.

Measurement is completely non-destructive and there is no need to remove coating.

Tests are useful for new steel grade qualification or process monitoring.



Consulting services

Based on the knowledge and data generated during the FormPlanet project, the Test Bed will develop complementary solutions to the innovative services. FormPlanet consulting services will include development of market studies and cost-benefit analyses; design of financing plans for SMEs; provision of objectivity and expert evaluation for consultation actions (regulation and standardization), and identification of optimal, best-for-value and competitive advantage solutions among others.



Training and knowledge

One of the main challenges the industry is facing is the difficulty to train new staff and integrate such knowledge to the existing personnel. The Test Bed offers specific and tailored-made training for potential clients delivered through virtual platforms or face-to-face training programmes.

Some of the organisations involved in the FormPlanet Test Bed are Universities, R&D Organisations, and SMEs with a very active role in the promotion of specialised training for experts in the different characterisation methodologies and other complementary services.



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This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No. 814517.