

# LOADING RATE

FROM  $10^{-6} \text{ s}^{-1}$  TO  $10^6 \text{ s}^{-1}$

## SHOCK LOADING

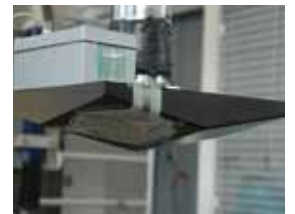
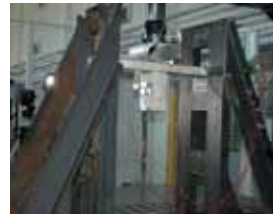
- SHPB shock loadings : tension, compression and torsion



- Planar shock wave
- Taylor Gun shock
- Laser induced shock

## DYNAMIC LOADING

- Impact testing on solids and fluids
- A constant actuator displacement rate at impact : (10m/s for  $F_{max}=200\text{kN}$  and 20m/s for  $F_{max}=100\text{kN}$ )
- Time resolved force measurement
- Slamming solid/wfluid interaction testing



## QUASI-STATIC AND FATIGUE LOADING

- Quasi-static tension, compression, torsion and bending loadings

- Cyclic loadings from 0.1Hz to 100 Hz

- Actuator displacement rate from  $10^{-6} \text{ mm/s}$  to  $10\text{mm/s}$



FROM  $-170^{\circ} \text{ C}$  TO  $1100^{\circ} \text{ C}$



Plate-Forme Technologique  
**MASMECA**  
 Advanced Experimental Mechanics on Materials and Structures  
[www.masmeca.fr](http://www.masmeca.fr)

## The MASMECA Technology Platform is located in Brest at ENSTA Bretagne.

The MASMECA team is composed of a highly qualified technical team comprising Engineers and Technicians. They carry out quality experiments and are committed to respecting deadlines.

MASMECA's activities are supported by experts and specialists in the field: researchers, lecturers and professors of the IRDL Research Institute. They guarantee reliable analysis and interpretation of the experimental results.

## ENSTA Bretagne campus

ENSTA Bretagne is a renowned multidisciplinary French Engineering Institute (French "Grande Ecole d'Ingénieurs") based in Brest (France, Brittany). ENSTA Bretagne offers specialized courses in Mechanics (Naval Architecture, Automotive Engineering, Energetic Materials, etc.) and IT. The Engineering diploma is equivalent to a MSc in Engineering. Research at ENSTA Bretagne is divided into 3 thematic poles: Mechanics, IT and Social Sciences. The excellence of ENSTA Bretagne is fueled by its privileged links with industry in the most innovative domains.



## Synergy with "IRDL" Laboratory: Dupuy de Lôme Research Institute

Research Institute Dupuy de Lôme (also named "IRDL") is accredited by the French Center of Scientific Research ("CNRS FRE 3744"). This laboratory is composed of research lecturers from ENSTA Bretagne and ENIB (Engineering Institutes, Brest), UBS and UBO (universities in Lorient and Brest). IRDL activities strive to improve knowledge of materials and mechanical engineering, in terms of life span. IRDL ranks as the French research institute reference in marine structures. IRDL also plays a key role in addressing current issues related to the engineering of materials and systems used in industrial sectors such as automotive, aerospace, food industry, energy, and health.

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**ENSTA**  
 Bretagne

Plate-Forme Technologique

# MASMECA



*Advanced Experimental Mechanics on Materials and Structures*



## ► 5 Technical Platforms

Cutting edge mechanical testing machines for advanced and complete characterization of materials, assemblies and structures

### *5 plateaux techniques*

*Des moyens d'essais de pointe et une équipe scientifique d'experts pour la caractérisation mécanique des matériaux, des assemblages et des structures*

- Mechanical behavior
- Durability and fatigue
- Shock and slamming
- Thermal and marine ageing



# SCALE RANGE

## FROM MATERIAL TO STRUCTURE

### STRUCTURAL SCALE



**Fatigue life of a welded car wishbone**  
Validation of self-heating modeling results taking in account welding process effect



**Hydrodynamic slamming test:**  
• Solid/fluid interaction



**Fatigue life of a naval propeller:**  
• Validation of modeling results taking in account casting process effect



- Uniaxial and multiaxial loadings

- Dynamic and shock loadings

- Hydrodynamic slamming

### SAMPLE SCALE



- Environment controlled quasi-static and fatigue testing under tension, compression, torsion and bending loadings

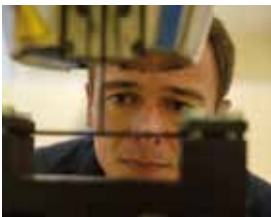
- In-plane and out-of-plane loadings

- Crack propagation and toughness measurement under mixed mode loading

- Thermal and marine ageing

- Dynamic and shock testing

- Planer wave shock testing



### MICROSTRUCTURE SCALE

- Micro-tension/compression/torsion testing

- Physico-chemical analysis

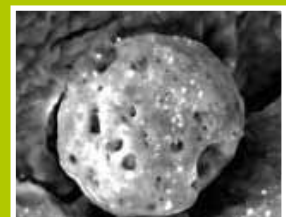
- Instrumented micro/nano indentation

- Long distance microscopy

- High resolution cameras (CCD, IR)

- In-situ testing

- Microscopic analysis



FROM -170° C TO 1100° C

# Thermomechanical characterization platform

The thermomechanical technical platform includes mechanical testing machines to a complete and advanced mechanical characterization of materials, assemblies and structures under uni-axial, multi-axial, static, fatigue loadings, in ambient air and in aggressive environment (T: -170°C up to 1100°C, HR: 20% up to 90%).

## MAIN EQUIPMENTS:

- A tri-axial servo-hydraulic platform (4mx6m) applying 2 actuators of  $\pm 400\text{kN}$  and an actuator of  $\pm 2500\text{kN}$  capacities
- 3 uni-axial tension-compression servo-hydraulic testing machines applying force range of:  $\pm 50\text{kN}$ ,  $\pm 100\text{kN}$  and  $\pm 230\text{kN}$
- 4 uni-axial tension-compression electro-mechanic testing machines applying force range of:  $\pm 5\text{kN}$ ,  $\pm 50\text{kN}$ ,  $\pm 100\text{kN}$  and  $\pm 200\text{kN}$
- 2 bi-axial tension-compression/ torsion servo-hydraulic testing machines applying force range of:  $\pm 100\text{kN}/1\text{kN.m}$ ,  $\pm 250\text{kN}/2.2\text{kN.m}$
- A high frequency tension-compression electro-dynamic fatigue testing machine Vibrophore  $\pm 100\text{kN}$



### TRI-AXIAL SERVO-HYDRAULIC PLATFORM

- Mechanical testing on structures at scale 1
- 2 actuators of  $\pm 400\text{kN}$ , Max loading frequency 5Hz,
- 1 actuator of  $\pm 2500\text{kN}$ , Max loading frequency 2Hz

### UNI-AXIAL TENSION-COMPRESSION SERVO-HYDRAULIC TESTING MACHINE

- Mechanical and thermomechanical testing on samples and structures
- Quasi-static and cyclic loadings
- Environment controlled testing
- Force range:  $\pm 50\text{kN}$ , Max loading frequency 50Hz



### UNI-AXIAL TENSION-COMPRESSION SERVO-HYDRAULIC TESTING MACHINE

- Mechanical and thermomechanical testing on samples and structures
- Quasi-static and cyclic loadings
- Environment controlled testing
- Force range:  $\pm 100\text{kN}$ , Max loading frequency 50Hz

### BI-AXIAL TENSION-COMPRESSION/ TORSION SERVO-HYDRAULIC TESTING MACHINE

- Mechanical and thermomechanical testing on samples and structures
- Quasi-static and cyclic loadings
- Environment controlled testing
- Force range:  $\pm 100\text{kN}$ ,
- Torque range:  $\pm 1000\text{N.m}$
- Max loading frequency 50Hz



### BI-AXIAL TENSION-COMPRESSION/ TORSION SERVO-HYDRAULIC TESTING MACHINE

- Mechanical and thermomechanical testing on samples and structures
- Quasi-static and cyclic loadings
- Force range:  $\pm 250\text{kN}$ ,
- Torque range:  $\pm 2200\text{N.m}$
- Max loading frequency 50Hz

# Dynamic characterization platform

The dynamic technical platform includes mechanical testing machines to mechanical characterization of materials, assemblies and structures under dynamic and shock loadings.

## MAIN EQUIPMENTS:

- High capacity servo-hydraulic shock machine applying a constant shock velocity on air or solid/fluid slamming tests: maximum of 20m/s and a force range up to 200kN.
- Split Hopkinson Pressure Bars : 2 compression SHPB, 1 tension SHPB and 1 torsion SHPB
- Taylor Gun (diameter 50 mm, 1.3kJ)
- Shock tube (4 m length, square section 80\*80 mm<sup>2</sup>)
- Pulsed laser (Nd:YAG, 3.7 J @ 1064 nm, 2 J @ 532 nm, 10 ns FWHM, 10 Hz)



### HIGH CAPACITY SERVO-HYDRAULIC SHOCK MACHINE

- Mechanical shock testing on samples and on structures at scale 1
- Solid/fluid slamming tests
- Constant actuator's velocity
- Force range: 200kN, Max velocity 20m/s

### SPLIT HOPKINSON PRESSURE BARS

- 2 compression SHPB
- 1 tension SHPB
- 1 torsion SHPB
- High frequency recording systems



### TAYLOR GUN

- Max diameter 50 mm
- Max energy 1.3kJ

### SHOCK TUBE

- Length 4 m
- Square section 80\*80 mm<sup>2</sup>
- Maximum pressure of 16 bar



### PULSED LASER

- Nd:YAG
- 3.7 J @ 1064 nm,
- 2 J @ 532 nm,
- 10 ns FWHM, 10 Hz
- High frequency recording systems



# Physico-chemical characterization platform

The physico-chemical technical platform includes mechanical testing machines to characterize material properties such as thermal properties ( $T_g$ ,  $T_m$ ,  $C_p$  ...) and transformation energies (enthalpy, crystallization, reticulation,...) . Low range force machines are available to determine the thermo-mechanical behavior of material, assemblies and small structures.

## MAIN EQUIPMENTS:

- Differential Scanning Calorimeter (DSC)
- Thermogravimetric Analyser (TGA)
- Dynamic Mechanical Thermal Analyser (DMTA)
- Differential dilatometer

- Electrodynamic testing machines
- Instrumented micro-hardness testing machine
- Instrumented nano-hardness testing machine



### DIFFERENTIAL SCANNING CALORIMETER (DSC)

- Temperature range from  $-170^{\circ}\text{C}$  up to  $600^{\circ}\text{C}$
- Environment controlled testing ( $\text{O}_2$ ,  $\text{N}_2$ )
- $T_g$ ,  $T_m$ ,  $C_p$  measurements
- Identification of polymer materials
- Crystallization and reticulation rate of polymer materials

### DYNAMIC MECHANICAL THERMAL ANALYSER

- Temperature range  $-70^{\circ}\text{C}$  up to  $450^{\circ}\text{C}$
- Environment controlled testing (T, RH)
- Force range : 150N
- Max loading frequency 100Hz
- IR Camera measurement
- Visco-elastic properties of polymer materials



### ELECTRODYNAMIC TESTING MACHINE

- Tension-Compression/Torsion loadings
- Quasi-static and cyclic loadings
- Thermomechanical environment controlled testing
- Force range:  $\pm 3.2$  kN,
- Torque range:  $\pm 24$  N.m
- Max loading frequency 100Hz

### INSTRUMENTED MICRO-INDENTATION TESTING MACHINE

- Force-displacement micro-hardness curve at micrometric scale
- Young modulus estimation
- Force range: 30 N
- Available tips: Vickers, Knoop and spherical



### INSTRUMENTED NANO-INDENTATION TESTING MACHINE

- Force-displacement nano-hardness curve at nanometric scale
- Young modulus
- Force range: 300 mN

# Measurements-observations platform

The measurements-observations technical platform includes measurement sensors, observation devices, optical and SEM microscopes.

## MAIN EQUIPMENTS:

- 3 Stereo Digital Image Correlation systems GOM-ARAMIS
- 2 High speed cameras (up to 1M image/s)
- 2 Infra-Red cameras
- 3 CCD cameras
- Uni-axial & bi-axial extensometers
- Long distance microscope
- ACPD measurement
- Optical microscopes
- SEM microscope
- FMP 30 Feritscope



STEREO DIC SYSTEM



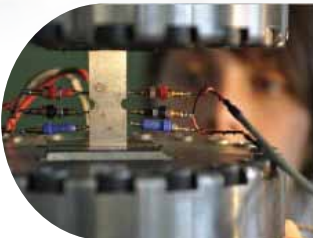
HIGH SPEED CAMERA



IR CAMERA



UNI-AXIAL & BI-AXIAL EXTENSOMETERS



ACPD MEASUREMENT



NUMERICAL MICROSCOPE



SEM MICROSCOPE



FMP 30 FERITSCOPE

# Prototyping platform

The prototyping technical platform supports MASMECA's need in terms of design and manufacturing of mechanical parts and experimental set-ups. It includes machining, milling welding and folding machines.

## MAIN EQUIPMENTS:

- CNC and conventional lathes
- Machining center
- Milling machine for composite materials
- Welding equipment
- Folding machine



CNC LATHE



MACHINING CENTER



CONVENTIONAL LATHE



MACHINING OF COMPOSITES

