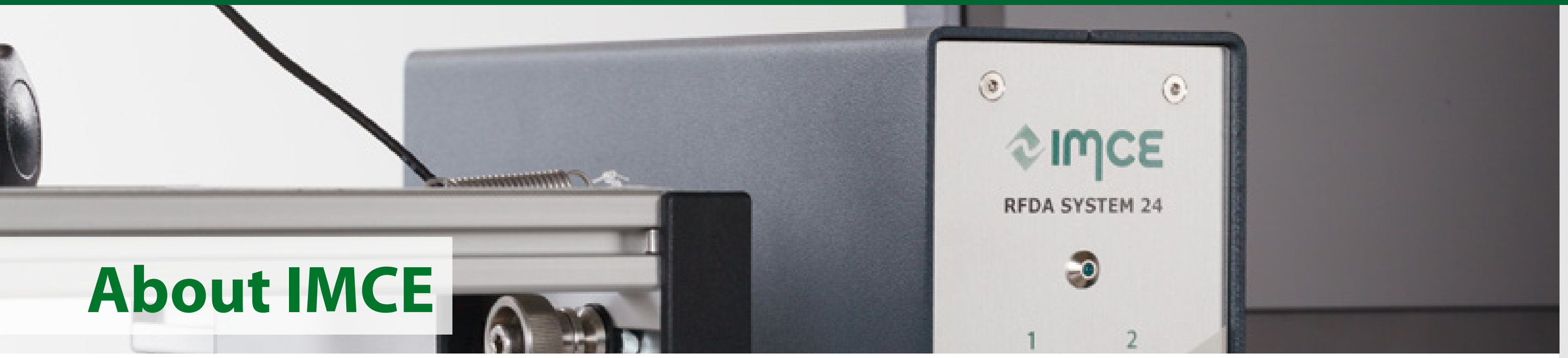


About IMCE

In the early 90's Adriaan Brebels, Theo Bollen and Bart Bollen started experimenting with the impulse excitation technique (IET) and developing systems for materials characterization. In 1995, IMCE NV was officially founded.

When we started our developments, the IET was already standardized (ASTM C 1259), but it was our intention, and still is, to bring the technique to a next level by focusing on the development of a robust signal analysis algorithm. Parallel with the development of the maths, we developed our own high temperature set-up. We improved the shortcomings of the standard furnaces to facilitate the IET measurements in a wide range of application fields.

Over the past 20 years IMCE has upgraded and extended their product range with different furnaces providing several, worldwide companies and universities with a non-destructive material characterization tool to research more than 15 different properties.

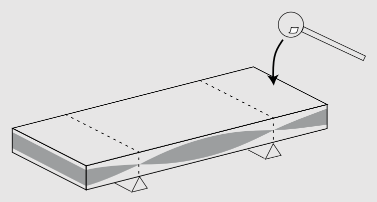
Impulse excitation technique

The impulse excitation technique (IET) is a non-destructive material characterization technique to determine the elastic properties and internal friction of a material of interest.

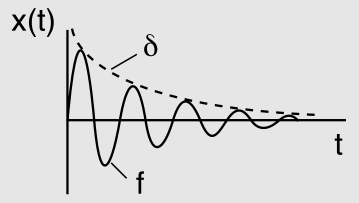
It measures the resonant frequencies in order to calculate the Young's modulus, shear modulus, Poisson's ratio and internal friction of predefined shapes like rectangular bars, cylindrical rods and disc shaped samples.

The measurement principle is based on tapping the sample with a small projectile and recording the induced vibration signal with a microphone or laser vibrometer. Afterwards, the acquired vibration signal in the time domain is converted to the frequency domain by a fast Fourier transformation. Subsequently, the dedicated software will determine the resonant frequency with high accuracy to perform mechanical spectroscopy based on the classical beam theory.

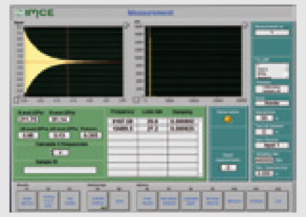
MECHANICAL EXCITATION



SIGNAL ACQUISITION



RFDA SOFTWARE



Advantages

- Non-destructive measurement of elastic and damping properties
- Large temperature range: -50 °C – 1700 °C
- Reliable, fast and easy accessible measurement technique
- Limited restrictions on sample geometry and dimensions
- Applicable to porous and brittle materials due to small strains
- Information about internal structure, damage, …

Relevant IET standards

ASTM standards
- ASTM E1876
- ASTM C1259
- ASTM C1548

ISO standards
- ISO 12680-1
- ISO 20343

EN standards
- EN 843-2
- EN 820-5

IMCE

NON-DESTRUCTIVE
MATERIALS CHARACTERIZATION

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IMCE

NON-DESTRUCTIVE
MATERIALS CHARACTERIZATION

MECHANICAL SPECTROSCOPY
BASED ON **IMPULSE EXCITATION TECHNIQUE**

Our products

ROOM TEMPERATURE

RFDA Basic

Manual elastic property measurements at room temperature:

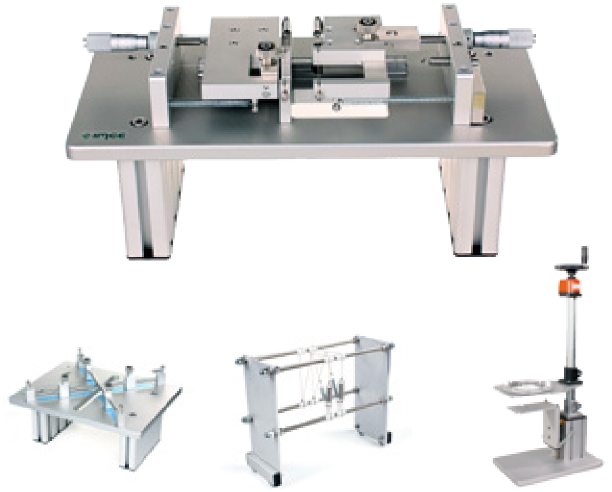
- In conformity with the ASTM E1876 standard
- Manual excitation
- USB microphone (10 Hz – 16 kHz)
- PC-based acquisition system
- Not upgradable to high temperature systems

RFDA Professional

Automated elastic property measurements at room temperature:

- In conformity with the ASTM E1876 standard
- Manual and automatic excitation
- Dedicated microphone (10 Hz – 100 kHz)
- DAQ-card based acquisition system
- Upgradable to high temperature systems

MEASUREMENT SUPPORTS



Wire supports for various sample geometries

- Flexural mode
- Torsional mode
- Longitudinal mode

MEASUREMENT SERVICES

Measurement of the Young's modulus, shear modulus, Poisson's ratio, internal friction and resonant frequency according to ASTM E1876 at room temperature and/or temperatures up to 1600 °C.

Contact us to discuss an optimal sample preparation.

HIGH TEMPERATURE

RFDA HT650/1050

- Measurements from RT up to 650 °C / 1050 °C
- Air atmosphere or inert gas flow (optional)
- Heating rate 1 – 5 °C /min
- Front sample loading
- Fixed position of microphone and excitation system

RFDA HT1600/1700

- Measurements:
  - HT1600: 1 sample from RT up to 1600 °C
  - HT1700: 2 samples simultaneously from RT up to 1700 °C
- Air atmosphere or inert gas flow (optional)
- Heating rate 1 – 5 °C /min
- Bottom charge furnace for easy sample loading
- Adjustable position of microphone and excitation system
- Sample lengths up to 160 mm
- Dilatometer optional

RFDA HTVP1600/1700

	HTVP1600	HTVP1700C
Temperature range	RT – 1600 °C	RT – 1700 °C (inert) RT – 1500 °C (vacuum)
Heating rate	1 – 5 °C/min	1 – 5 °C/min
Atmosphere	Air, inert or reducing	Inert or vacuum
Insulation	Al_2O_3 (PCW)	Carbon
Vacuum pump	Rotary vane	Turbomolecular
Min. pressure	1 mbar	10^{-2} mbar

LOW TEMPERATURE

RFDA LTVP800

- Measurements from -50 °C up to 800 °C
- Vacuum atmosphere (10^{-4} mbar)
- Fast heating rates (1 – 60 °C/min) due to infrared heating
- Indirectly sample cooling with LN2
- Laser vibrometer to detect the vibration signal

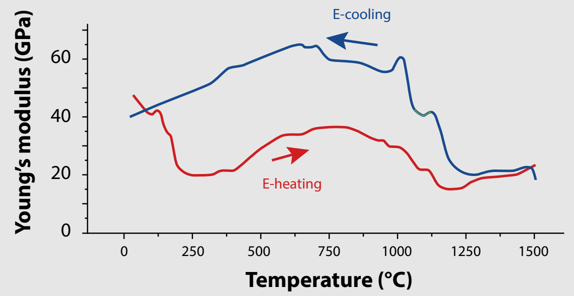
Resonant Frequency & Damping Analysis (RFDA): Mechanical Spectroscopy based on Impulse Excitation Technique

Application domains:

Material Properties

1. Elastic properties
   - Young's modulus
   - Shear modulus
   - Poisson's ratio
   - Damping
2. Relaxation
3. Creep
4. Brittle to ductile transition temperature
5. Debye Temperature

ACS Torpedo bricks

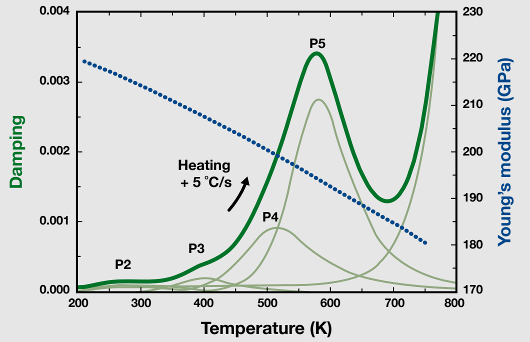


K. Andreev et al., Compressive behaviour of ACS torpedo bricks, 11th Biennial worldwide conference on Unified International Technical Conference Refractories, pp. 932-936, 2009.

Material Crystal Structure

1. Solid Solution
2. Diffusion
3. Phase Transition
4. Point defects
5. Dislocations

Press-hardened 22MnB5 steel

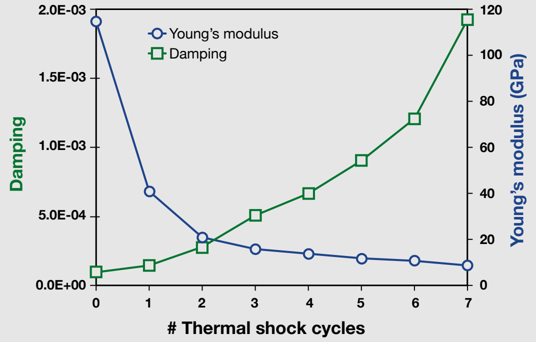


Choi, W. S. et al., Internal-friction analysis of dislocation–interstitial carbon interactions in press-hardened 22MnB5 steel. Materials Science and Engineering: A, 639, pp. 439-447, 2015.

Material Damage

1. Thermal
2. Strain
3. Cyclic Loading
4. Radiation
5. Gasses

High alumina castable



T. Tonnesen et al., Evaluation of Thermal Shock Damage in Castables by a Resonant Frequency and Damping Method, Proc. 49. Int. Feuerfest-kolloquium, pp. 133-136, 2006.

System Controls

1. Quality of systems
2. Structural Damping
3. Flaw Inspection

Visit our website for more relevant references.

www.imce.net