

A grayscale background image showing a close-up of a gear with several spheres arranged in a circular pattern on its surface.

THERMOCHEMICAL & HEAT TREATMENT

Development and industrialization of thermochemical and heat treatment processes

Performance requirements for mechanical parts are becoming increasingly stringent: fatigue resistance, corrosion resistance, tribological behavior, complex geometries, noise reduction, etc.

IRT M2P develops and optimizes processes that meet and go further than current specifications while also striving to be more cost competitive and environmentally friendly.

Through our semi-industrial scale equipment, we reproduce industrial conditions in order to obtain reliable metallurgical data to model and then optimize thermochemical and heat treatment processes.



EXPERTISE & SERVICES

R&D studies and services in thermochemical and heat treatment

Implementation of thermochemical treatment, vacuum heating, cryogenic and gas quenching
Development and optimization of treatment ranges
Development of specific recipes (carburizing, nitriding, etc.)
Study of the influence of thermochemical treatment on the performance of materials (fatigue resistance, tribological behavior)
Hybridization of technologies
Development carried out on prototype parts including technical and economic feasibility studies
Water spray quenching of long products (rods, tubes, and plates)
Quenching via surface induction heating
Consumption monitoring, production costs estimation
Study of the environmental impact of various thermochemical and heat treatment processes

Characterization, material control and chemical analysis

Metallography (optical microscope, SEM, micro-hardness)
Chemical analysis (GDOES, ICP, XRD, OES, etc.)

Simulation

Phase diagrams, diffusion (Thermo-Calc, DICTRA)
Modeling of solid/gas interactions and phase transformations related to composition gradients (Carbon, Nitrogen)
Prediction of residual stress profiles
Determination of heat transfer coefficients by numerical calculation
Optimization of treatment by numerical simulation



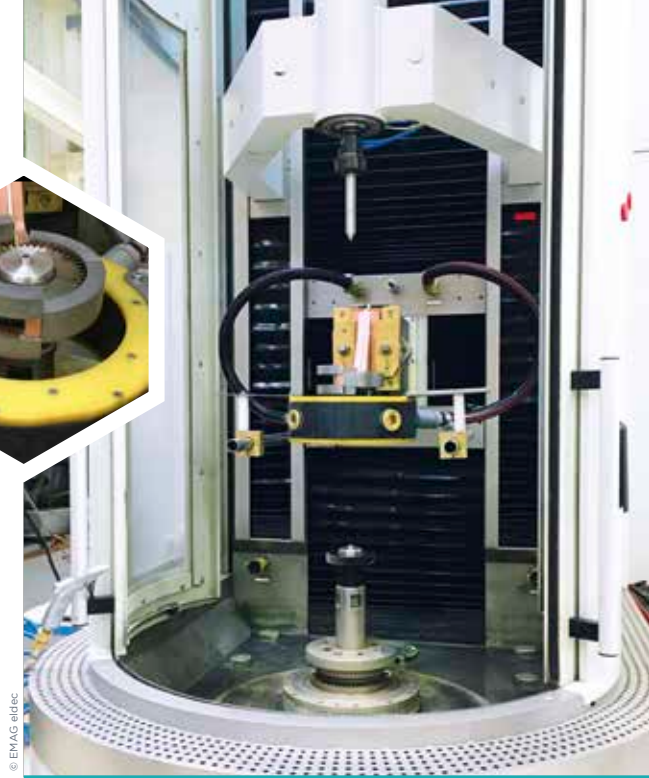
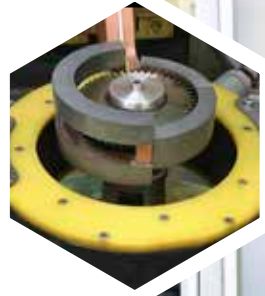
TECHNOLOGY

IRT M2P is equipped with state-of-the-art industrial pilots, for the development, optimization, and modeling of thermochemical and heat treatments. All available equipment is scalable and equipped with various sensors and process logic controls allowing real-time data acquisition and analysis and advanced tools for optimizing processes.

- **Low pressure carburizing and carbonitriding, gas quenching up to 20 bars**
Material properties are optimized by the control of process parameters during enrichment step (treatment time, temperature, chamber pressure, injected gas flow) and during quenching (duration, pressure, turbine speed)
Clean parts, low gas consumption and reduction of deformations, treatment of complex geometries
- **Gas nitriding at atmospheric/low pressure, oxynitriding, nitrocarburizing**
Homogeneity of the treatment atmosphere, precise control of process parameters (temperature, pressure, holding time, carbon and nitrogen enrichments: gas flow rates, KN, KC), pre- and post-oxidation treatments)
- **Ion nitriding**
Control of iron nitrides layers for tribological applications
Nitriding of stainless steels
Improve health and safety conditions
- **Nitriding in austenitic phase**
Keeping stainless properties of steels after nitriding
Reduction of the time of treatment and increase of treated layers depths
- **Contour hardening by induction quenching**
Control of the quenching depth to optimize materials properties gradients
Possible automation, productivity gains compared to traditional thermochemical treatments
- **Spray quenching (water, air, biphasic) of long products**
Control and experimental simulation of quenching conditions used in industry
Calculation of heat transfer coefficient using the inverse method
- **Cryogenic quenching**
Control of phase proportions

APPLICATIONS

- Surface reinforcement of mechanical parts (gears, bearings, tools, etc.) for the aerospace, automotive, marine, and mechanical fields:
Increase of fatigue life
Improvement of tribological properties
- Cleaner and more energy efficient processes
- Productivity gains by reducing nitriding treatment times, while maintaining mechanical properties



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EQUIPMENT @M2P

LOW PRESSURE CARBONITRIDING FURNACE

- T°max: 1050 °C
- Adjustable treatment pressure
- Gas quenching: 1 to 20 bars (N₂ and/or CO₂ and/or He)
- Useful area: 650 x 400 x 400 mm

GAS NITRIDING FURNACE

- T°working: 200 - 700°C
- Atmospheric or low pressure
- Useful area: 900 x 600 x 600 mm

ION NITRIDING FURNACE

- T°max: 600°C
- Plasma technologies: DCPN (Direct Current Plasma Nitriding) or ASPN (Active Screen Plasma Nitriding), Additional heating
- Useful area: 800 x 800 mm

CONTOUR HARDENING PLATFORM WITH INDUCTION HEATING

- Simultaneous double frequency generator: 450 kW MF - 200 kW HF

SPRAY HARDENING PILOT

- Instrumentation by 16 thermocouples
- Adjustable spray systems (geometries, fluids, pressure, speed)

CRYOGENIC ENCLOSURE

- Tworking: -100 - 250°C

RELATED ACTIVITIES

MECHANICAL SURFACE TREATMENT

Mechanical surface treatment can be advantageously associated with thermochemical surface treatment to increase the compressive stresses on the near surface and thus improve the fatigue life of mechanical parts.



ANALYSIS & CHARACTERIZATION

All the means necessary to characterize the properties obtained after heat and thermochemical treatment are available (metallography laboratory, SEM, SDL, micro durometer, etc.)



About IRT M2P

The Institute of Research and Technology for Materials, Metallurgy & Processes (IRT M2P) is your partner for developing innovative products and processes to accelerate your company's growth.

We bring our expertise, a wide array of state-of-the-art semi-industrial technological platforms and a network of academic labs to the R&D projects we carry out with our more than 120 industrial partners.

Working together

- Multi-partner research projects with private/public co-funding
- Private research studies, tailor-made services
- Small series & prototype production
- Training

Contact us to discover our 9 areas of technological expertise:

- > Advanced Foundry
- > Life Cycle Assessment & Recycling
- > Metal Powders
- > Surface Treatment & Coatings
- > Mechanical Surface Treatment
- > Heat & Thermochemical Treatment
- > Composite Materials
- > Multimaterials Joining
- > Analysis & Characterization



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