Company presentation
Top Innovation, Complex service in metals

This is COMTES FHT a.s.
Model example: Development of new material

1. An idea arising from basic and applied research
2. Numerical and physical simulations of processes and properties of materials
3. Metallurgical processing of experimental materials (melting, casting, forming, heat treatment)
4. Materials analysis
5. Product or technology with new added value
Model example: Development of new material
West-Bohemian Centre of Materials and Metallurgy (WBCMM)
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COMTES FHT a.s. Complex view
Examples of successful R & D

Patents
- 299495: A method for producing high-strength low-alloy steel tubes
- 301718: Method of processing semi-finished steel temperature above Ac1
- 302676: Method of annealing steel blank
- 302940: The method of work hardening the surface of the metal blank and device for performing this method

Utility models
- 22084: The skeleton of the seat frame of public transport
- 23289: Equipment for corrosion tests in steam at high temperatures
- 24922: Forming device for the continuous production of fine grained blanks of high-strength metal.

Established technology
- VÍTKOVICE HEAVY MACHINERY a.s. – technology of forging of cam
- GMA Stanztechnik Kaplice s.r.o. – Forming of neck for thread

Publications
- Papers in journals with impact factor, citations and others
Metallurgical Technologies
Metallurgical Technologies

- Casting of ingots and die castings in VIM furnace, max. lot 50 l (steel, Ni alloys, Al alloys etc.)
- Alloying in protective gas
Metallurgical Technologies

- Forging of ingots up to 1 t, forging of small specimens, prototyping
- Open and closed die forging
- Program based forging (automatic open die forging)

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Max. power</td>
<td>2 500 t</td>
</tr>
<tr>
<td>Working table</td>
<td>800 x 800 mm</td>
</tr>
<tr>
<td>Max. stroke</td>
<td>500 mm</td>
</tr>
<tr>
<td>Max. opening</td>
<td>900 mm</td>
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</tbody>
</table>

New forging press 2 500 t at COMTES FHT
Metallurgical Technologies

- Hot and cold rolling of bands and sheets down to 0.2 mm on reversible rolling mill (both two-high or four-high mill can be used)
- Thermo-mechanical rolling

**TWO-HIGH MILL**

Hot rolling
- Max. reduction 100 mm
- Max. temperature 1250°C
- Rolling down to 2 mm

**FOUR-HIGH MILL**

Cold rolling
- Max. reduction 10%
- Rolling down to 0.2 mm
- Hardening in a vacuum furnace and/or conventional furnaces
- Deep cryogenic treatment using liquid nitrogen
- Thermo-chemical treatment (nitriding, carburizing, boronizing)
Metallurgical Technologies

- Optimizing of tools lifetime through improved heat treatment strategy
- Deep cryogenic treatment for wear resistance improvement of tool steels Werkzeugstählen (patents applied)

Influence of deep cryogenic treatment on nitriding
Metallurgical Technologies

- Complex services for industrial application of induction heat treatment (hardening, normalising, soft annealing etc.)
- Incl. projects of induction lines, design and manufacturing of inductors etc.

Applications of induction heat treatment - examples
Metallurgical Technologies

Conform™

- Grain refinement
- Material flow analysis
- Temperature analysis
Computer Modelling
Computer Modelling

Development Design

- development of tools and jigs
- analysis of static and dynamic problems
- optimising and extending lifetime of structures
- development of non-conventional joint types
- component geometry for numerical modelling
- programming CNC machine tools

Simulation of Manufacturing Processes

- preparation of material property data for numerical simulations
- design and optimisation:
  - conventional forming processes (forging, rolling, extrusion, tube manufacturing)
  - special forming processes (hydroforming, SPD, microforming)
  - heat treatment, thermochemical treatment and thermomechanical treatment
  - induction and resistance heating
Computer Modelling

Development Design

- Development of components and structures
- Optimisation of structures, material selection
- Extending the life of structures
- Tools and fixtures for forming and heat treatment
- Tools for special forming methods
- Fixtures for mechanical testing shops
- Development of alternative joints of special materials
- Programming of CNC machine tools

Software:
- CAD packages: AutoCAD, SolidWorks, SolidEdge
- GibbsCAM software for CAM
- FEM packages: MSC.Marc, Nastran, Dytran, XFlow

www.comtesfht.cz
Computer Modelling

Development Design

Versatile grips for a thermomechanical simulator

CAD model → Numerical simulation → Testing device
Computer Modelling

Simulation of Manufacturing Processes

- Adapting materials data for numerical simulation

- Design and optimisation:
  - conventional forming processes (forming, rolling, extrusion, tube production)
  - special forming processes (hydroforming, SPD, microforming)
  - heat, thermochemical and thermomechanical treatment processes
  - induction and resistance heating

- Software:
  CAE software DEFORM
  JMatPro software for computing materials properties
Thermo-mechanical properties calculation based on chemical composition

- Input of chemical composition
- Calculated flow stress curves
Explosive forming: alternative joining techniques

CAD model

Numerical simulation

Test sample
Computer Modelling

Simulation of Manufacturing Processes

Production of rail wheels - procedure
Simulation of blade forging
Computer Modelling

Project forging software – Open die forging solution

- Fast and precise design of a new manufacturing process
- Repeatability of production with the same quality
- High accuracy
- Documentation of production

Developing diagram of open die forging
Thermochemical treatment

Diffusion of carbon in teeth region.

Calculation of phase composition.
Material analyses
Material analyses

**Services:**

- Evaluation of microstructures (ferrous and non-ferrous metals)
- Phase analysis, identification and measurement of volume fraction
- Evaluation of porosity in alloys
- Chemical composition measurement by means of EDX (pint, line, area mapping)
- Fractography
- Hardness measurements (in the laboratory, outside the laboratory)
- Measurement of the layer thickness
- Failure Analysis, case studies
Material analyses

**Facilities**

- 4 optic microscopes (Nikon and Carl Zeiss)
- 2 scanning electron microscopes (Jeol with EDX and EBSD)
- Preparation of metallographic samples with modern machinery

Struers and Buehler
Material analyses

Metallography of metals and alloys

Clockwise:
- nickel alloy
- cast aluminum alloy structure
- duplex steel annealed for the occurrence of sigma phase
Macro and microstructure

Macrostructure – heel /alloy pin FeNi42
Material analyses

Electron microscopy

EDX map - distribution of chromium in the powder material

EBSD Analysis of non-uniform recrystallization process
Microhardness measurement

Equipment: Struers DuraScan – 70 EMCO-TEST Prüfmaschinen GmbH

- Fully automatic testing cycle
  (select load / penetration / Focus / evaluation of hardness)

- Load **0.098 to 98.1 N**

- Measurement of micro and macrohardness

- Automatic table 200 x 120 mm accuracy 0.008 mm
Material analyses

Fractography

<table>
<thead>
<tr>
<th>Spektrum</th>
<th>S [%]</th>
<th>Cr [%]</th>
<th>Fe [%]</th>
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<tbody>
<tr>
<td>1</td>
<td>9.65</td>
<td>90.35</td>
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<tr>
<td>2</td>
<td>1.98</td>
<td>9.43</td>
<td>88.58</td>
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<tr>
<td>3</td>
<td>9.01</td>
<td>90.99</td>
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### Accredited laboratory

<table>
<thead>
<tr>
<th>No</th>
<th>Description</th>
<th>Identification</th>
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<tr>
<td>1</td>
<td>Metallographic determination of non-metallic inclusions</td>
<td>ČSN ISO 4967, DIN 50602, ASTM E 45</td>
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<tr>
<td>2</td>
<td>Grain size determination</td>
<td>ČSN EN ISO 643, ASTM E 112</td>
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<tr>
<td>3</td>
<td>Microscopic observations thickness</td>
<td>ČSN EN ISO 3887- čl. 4.2</td>
</tr>
<tr>
<td>4</td>
<td>Rating metallographic structure of cast iron</td>
<td>ČSN EN ISO 945</td>
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<tr>
<td>5</td>
<td>Determination of the proportion of surface phase image analysis</td>
<td>ASTM E 1245</td>
</tr>
<tr>
<td>6</td>
<td>Rating micro / macro structure</td>
<td>ČSN EN 1321</td>
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<tr>
<td>7</td>
<td>Vickers hardness</td>
<td>ČSN EN ISO 6507-1</td>
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<tr>
<td>8</td>
<td>Rockwell hardness test</td>
<td>ČSN EN ISO 6508-1</td>
</tr>
<tr>
<td>9</td>
<td>Front steel hardenability test</td>
<td>ČSN EN ISO 642</td>
</tr>
</tbody>
</table>

Material analyses

Expert activities

Problem: The surface of the workpiece with defects

Result: Excessive presence of large oxide inclusions - metallurgical defect

EDX analysis
Mechanical Testing & Thermophysical Measurement
Mechanical Testing

- Accredited tests (tensile tests, instrumented Charpy tests, hardness)
- Static and dynamic tests (tensile, compression, bend) up to velocity 25m/s, dynamic testing of Young’s modulus
- Wide testing temperature range (-200°C to 1400°C)
- High- and low-cycle fatigue tests (Manson-Coffin a Wöhler curve)
- Short-time creep tests
- Miniature-sample testing
- Torsion and biaxial testing
- Transition temperature determination
- Fracture toughness tests
  • J-R k-curves
  • Master curves
  • Fatigue crack growth rate, threshold value
- Component testing
- Non-standard tests per customer request
Optical measurement systems
- ARAMIS, video-extensometer, laser-extensometer, high-speed camera
- Contactless measurements with data acquisition
- Ensure precise deformation measurements
- Available even for dynamic testing

System ARAMIS

Digital Image Correlation (DIC)
- Optical measurement method
- Measurement of surface deformation of tested sample
- 2D (1 camera) or 3D (2 cameras) measurement
- Video-extensometer
- True Stress-True Strain diagram measurements
- Flowing Limit Curve (FLC, FLD)
ARAMIS - Digital Image Correlation

Mechanical Testing
Mechanical Testing

ARAMIS – FLC diagram
(Flowing Limit Curves)
Mechanical Testing

**Dynamic testing**
Impact tester IMATEK IM10T-30HV

**Technical parameters:**

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Range</th>
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</thead>
<tbody>
<tr>
<td>Drop Height</td>
<td>50 mm to 3000 mm</td>
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<tr>
<td>Drop Weight</td>
<td>8 kg to 100 kg</td>
</tr>
<tr>
<td>Velocity Range</td>
<td>1.0 m/s to 25 m/s</td>
</tr>
<tr>
<td>Energy Range</td>
<td>2.5 J to 3000 J</td>
</tr>
<tr>
<td>Temperature Range</td>
<td>-70 °C to +200 °C</td>
</tr>
</tbody>
</table>

**High-speed camera Phantom v710 1 Mpx camera**
- Full resolution 1250x1080px at 7 500 fps
- Lower resolution 128x8px at 680 000 fps

**Possible tests**
- tensile, compression, three-point bend …
- dynamic component testing
Mechanical Testing

Miniature-sample Testing - Small Punch Test (SPT)
- Sample-disc dimensions only D=8mm, t=0,5mm
- Stress-strain characteristics measurement
- Tensile properties determination
- Transition temperature measurement
- Estimation of fracture toughness
Miniature-sample Testing – Micro-tensile Tests

- Sample dimensions comparable to SPT disc
- Deformation measurements using ARAMIS system
- Tensile diagrams identical with standard tests
Special Device for Sample Extraction

Electric Discharge Sampling Equipment

- „Non-destructive“ extraction of samples from devices in use
- Extracted sample is further analyzed
- Mechanical testing (Small Punch test, micro-tensile tests)
- Hardness measurement
- Chemical composition determination
- Microstructure analysis
- Residual life determination
Thermophysical Measurements

**CCT and TTT diagrams**

Hardening dilatometer LINSEIS L78 RITA

- Induction heating – high heating rate (up to 200°C/s)
- Measurements in vacuum and inert gas, vacuum $10^{-2}$ Pa
- Temperature range from -160 °C to 1 600 °C

**Further use:**

- Isothermal modes (annealing, tempering)
- Highly dynamic modes (welding, hardening)
- Phase transformation during dynamic modes and estimation of phase fractions at a given temperature and time

processes optimization
Determination of temperatures of phase transformations and thermal expansion

High-temperature dilatometer LINSEIS L75HS1600C PT

- Temperature range from 20 °C to 1600 °C,
- Heating rate from 0.6 °C/min to 20 °C/min,
- Inert gas, vacuum 10⁻² Pa,
- Measurement range from 100 µm to 5000 µm
- Maximal resolution 0.125 nm/digit.

Further use:
- Study of recrystallization and recovery
- Slow and isothermal modes (annealing, slow cooling in furnace)
- Determination of coefficient of thermal expans.
- Estimation of phase fractions
Thermophysical Measurements

Calorimetric measurements
High-temperature calorimeter LINSEIS DSC HDSC PT1600

- Temperature range 25 to 1400 °C,
- Heating and cooling rate from 0.1 to 50 °C/min
- Measurement accuracy +/- 0.5 °C,
- Inert gas, vacuum 10^-2 Pa,
- Sample dimensions max. Ø 5 mm,
- Resolution 0.3 μW.

Further use:
- Temperatures and enthalpy of phase transformations
- Study of recrystallization and recovery
- Study of precipitation and precipitate dissolution
- Specific heat capacity determination
- Melting point determination
Thermophysical Measurements

Thermal diffusivity and thermal conductivity
LINSEIS Laser Flash LFA-I 000/1400 °C

- Temperature range from 25 to 1400 °C
- Inert gas, vacuum 10-2 Pa
- Measurement accuracy ≤5%
- Measurement repeatability ≤5%
- Sample diameter 12.7 mm or 25.4 mm
- Holder for 3 or 6 samples

Further use:
- Thermal diffusivity measurement
- Thermal conductivity determination
Simulation of the Forging Process
Servo-hydraulic system MTS 810 with resistance heating

- Heating / cooling rate 150 °C/s
- Temperature range - 150°C to 1 400 °C
- Max. cyclic loading 30 Hz
- Max. loading velocity 600 mm/s
- Max. force 250 kN

Further use:
- Complex modelling of the forming process
- Choise of temperature and deformation characteristics
- Simulation of forming parameters influence on final microstructure
Thermophysical Measurements

Customer-based tests

Mechanical properties of undercooled austenite

- Electromechanical testing machine Zwick/Roell 250 kN, laser extensometer, induction heating, fast cooling
Company
of the Year 2011
Pilsen Region

BEST INNOVATOR 2012

1. místo v kategorii „Malé a střední podniky“
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- ZDAS
- MECAS ESI s.r.o.
- CPF CZECH PRECISION FORGE
- SKODA AUTO
- SKCR
at the end…

With the most modern knowledge in R & D we achieve global competitiveness

We look forward to cooperation with you!