WEST-BOHEMIAN CENTRE OF MATERIALS AND METALLURGY

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Abstract

Under the auspices of the National Programme for Research and Development and with the funding from the Operational Programme Research and Development for Innovation (RDI), a project entitled West-Bohemian Centre of Materials and Metallurgy (WBCMM) was launched in Dobřany near the city of Pilsen in January 2011. By the end of 2014, a new metallurgical hall and a building with modern laboratories will be erected on the research premises of the company COMTES FHT a.s. This paper outlines the main objectives of the project, its technical details, planned technological equipment and the research tasks to be dealt with at the project implementation stage.

Keywords: COMTES FHT, WBCMM, West-Bohemian Centre of Materials and Metallurgy, applied research, metal forming

1. INTRODUCTION

The West-Bohemian Centre of Materials and Metallurgy (WBCMM) will be built in Dobřany near Pilsen by the company COMTES FHT a.s. with the budget of 430 million Czech crowns by the end of 2014. The company is a private non-profit research organization and was founded in the year 2000. Its core business activity is materials research and development, focused primarily on metals. Those include structural and tool steels, aluminium, nickel, titanium and copper alloys. The body of activities of COMTES FHT a.s. includes:

- **Materials research** aimed at designing and testing materials with new chemical compositions and materials produced by new methods of processing bulk stock. Detailed analyses of physical metallurgical phenomena are used for obtaining modern materials with attractive properties. Attention will be paid to:
  - intensive refinement of microstructure
  - recrystallization processes in high-alloyed materials
  - transformation and twinning induced plasticity
  - rapid softening processes
  - thermodynamic stability of phases
  - advanced tool steels
  - new aluminium, nickel, titanium and copper alloys

- **Manufacturing technology research**
  a. Optimization of conventional forming and heat treatment methods
  b. Development and trials of new processes

Development of new technological processes normally comprises:
a. Numerical modelling of processes to obtain prediction of key parameters: temperature, stress and strain distributions throughout the volume of the workpiece and during the entire process. Modelling of material flow, loads on tools and determining energy and force parameters of the machine

b. Physical simulation, where samples of the material are subjected to thermal and deformation processes, matching the real-world process as closely as possible. Obtaining information on the microstructure and mechanical properties in the treated material. Combining numerical and physical simulations provides a very good background for optimizing the process.

c. The final stage normally consists in trials and prototype production in accordance with the innovated technology, taking place either at COMTES FHT or on customer's premises.

- **Testing and measuring of materials data** take up a great amount of the company's capacity. There are a mechanical and a metallographic accredited testing shops. Unique experimental equipment of the laboratories enables thermomechanical, thermophysical and magnetic quantities to be measured across a wide range of temperatures. The data obtained is often used for refining numerical models of manufacturing processes.

- **Consultancy and educational activities** represent another key field of activity. The company's laboratories are used for experiments conducted as part of diploma and doctoral theses of students of Czech and foreign universities. COMTES FHT organizes conferences, seminars and consultancy sessions for interested persons from academia and industry.

The services offered are used by a wide spectrum of clients ranging from research and development organizations and manufacturing companies to universities. The research organization COMTES FHT has 41 employees and its turnover in 2010 was above CZK 58 million. The company has its headquarters and its own research premises in the town of Dobfany. Over the relatively short period of its existence, COMTES FHT a.s. has built a stable team of 28 researchers, laboratories with modern equipment and won specialist renown in both domestic and foreign markets. Since 2008, COMTES FHT a.s. has the status of a research organization according to the European Community Framework.

2. **THE PROJECT**

The objective of the project West-Bohemian Centre of Materials and Metallurgy is to build a research centre expanding the current range of activities of COMTES FHT a.s. to encompass manufacturing and processing of new metallic materials for engineering, construction and other branches of industry. It is carried out under the National Program for Research. By a Decision of the Minister of Education, it was awarded a grant from structural funds of the EU under the Operational Program Research and Development for Innovation in the amount of CZK 350 million.

From 2012, i.e. after completion of capital development of the research premises and capital projects for procuring equipment, COMTES FHT a.s. will substantially expand the research and development activities it offers and will be able to offer a comprehensive range of services. The Centre will pursue both contractual research for Czech and foreign public and private research entities and collaborative research activities.

2.1 **Key Objectives**

- Building a strong prestigious regional centre with state-of-the-art laboratories staffed by experienced and professionally advanced researchers.
- Strengthening the research, development and innovation capacities of the region.
- Creating new jobs for young researchers in the West Bohemia.
- Offering research and development services – up to the verification stage and prototype trials.
- Carrying out two research programmes with six research projects.
Accelerating the transfer of applied research knowledge to academic teaching and education.
Contributing to sustainable development of competitiveness and growth of Czech economy.

2.2 Location of the Centre
The Centre will be built on the research premises of COMTES FHT a.s. in the industrial park in Dobřany near Pilsen. A new metallurgical hall with an area of 2,480 m² will be erected. A laboratory building annex with a total area of 790 m² built under the project will house new laboratories for materials research.

3. RESEARCH PROGRAMMES

The implementation phase of the WBCMM project starting on 1st July 2012 will comprise two research programmes. Each programme includes three interrelated applied research projects.

3.1. Thermomechanical Treatment of Advanced Steels
The programme will involve development of new grades of steel with excellent combinations of properties. New technologically viable thermomechanical treatment processes will be developed for selected existing and newly designed steels and for application in concrete manufacturing companies. The programme will be carried out in the form of three sub-projects:

- Processes for Controlled Microstructure of Steel
- Forming technologies producing ultrafine microstructures
- Technologies producing high-quality surface in formed products

Planned outcomes are the following:
- Expanding the usability of wrought structural steels. Thanks to newly developed grades of steel, combinations of properties that have not yet been available will be achieved. They make the use of steel possible in areas where other, considerably more expensive, alloys or difficult-to-recycle composites have been used to this date: for instance, in the area of transport technology, power engineering, production of tools and in the sports industry.
- Cost reduction. Application of advanced forming, heat treating and thermomechanical treatment procedures will bring energy savings and significantly improve the surface quality. In a number of cases, the costs of surface machining will be reduced or completely eliminated. The duration of heat treatment procedures such as soft annealing, grain refinement annealing, recrystallization annealing, and normalizing, will be substantially reduced. In some cases, thermo-mechanical treatment will completely replace the hardening and tempering process or the normalizing process.
- Increasing the end-use value of current wrought structural steels. Expected outcomes include, for instance, longer life, higher reliability, in some cases lower weight and improved weldability.
- Acquiring new knowledge. New findings from individual projects will be published in professional journals and presented at conferences.

3.2. Metallic materials for special applications
The research programme will yield materials with new quality characteristics, as well as manufacturing and treatment procedures for their production. They are intended for future producers of such materials and for those engaged in their processing. The programme will be carried out in the form of three sub-projects:

- Lightweight Super-High-Strength Alloys for Medical and Transport Applications
- Nickel Superalloys for Power Engineering
- Tool Steels for Forming Tools

Planned outcomes are the following:
- High-strength sheets and sections of aluminium alloys. They are expected to be utilized in the automotive, aerospace and rail vehicle sectors.
o New technologies for forming semiproducts from aluminium alloys. These will employ techniques for imparting severe deformation and refining grain in materials. They are expected to be used in the automotive, aircraft and rail vehicle sectors.

o Sections from nanostructured titanium with good biocompatibility and high strength. They are expected to find their niche in dentistry and surgery for implant production. The high strength of the nanostructured material will allow the use of more delicate joint and dental replacements with identical overall strength and, consequently, less invasive procedures.

o Forming technology for modified Mo-Ni-Cr superalloys. Procedures for the production of strips, tubes and sections. Guidelines for temperatures, reduction amounts and pre-production preparation of the material for successful working. Expected utilization in nuclear power engineering.

o Guidelines for processing procedures for selected nickel and iron alloys. The implementation will lead to new specifications for selection of input raw materials, new melting and casting technologies, optimized soaking procedure for forming and optimized forming procedure and creating new processes of recrystallization annealing for cold rolling. The results will be utilized in the electrical engineering industry.

o New tool steel grade. The experimental equipment put in operation under the project will allow an optimum chemical composition, melting procedure and effective forming and heat treating procedures to be found. The new materials will be used in companies engaged in forming metals at elevated temperatures.

o New findings. The obtained findings will be published in professional journals and presented at scientific conferences.

4. INSTRUMENTS AND EQUIPMENT TO BE PROCURED

An essential pre-condition for implementing the WBCM project and research programmes is the installation and commissioning of new technology, instruments and equipment over the course of the project. The procurement of machines and equipment makes the largest item of the budget: 53%. The planned equipment consists of the following groups:

4.1 Metallurgical Processing Equipment

- Universal hydraulic forming machine
- Four-high rolling mill (KVARTO) with accessory equipment
- Vacuum melting furnace
- Laboratory furnaces for experimental treatment of small samples

At present, there is no hall laboratory of this kind in the Czech Republic. It will allow development and optimization of metal processing technologies up to production of series of prototypes tailored to the needs of customers. It will also boost the cost efficiency and pace of research. This equipment will add to the research potential of the existing centre the capability to manufacture experimental materials (up to the mass of 200 kg). The forming machines installed will be capable of simulating the operation of hydraulic and screw presses, for instance. They will also allow the range of clients from industry to be expanded.

4.2 Equipment for Metallographic Analysis

- Light microscope
- Microhardness tester
- Metallographic sample preparation shop

4.3 Set of Testing Machines

- Universal electromechanical testing machine 250 kN
- Electromechanical testing machine with rapid deformation capability, 10 kN
- “Small punch” – equipment for taking samples
4.4 Computer Hardware

- Dilatometer
- Calorimeter and differential thermal analysis equipment
- “Pin on disc” tester
- Spectrometer for melt analysis

4.5 Software

- Computational and graphics workstations for CAD and CAE systems
- DEFORM, ABACUS computing software

5. SERVICES

In the region, there will be two other organizations engaged in research and development in addition to WBCMM. These are the University of West Bohemia in Pilsen and the Research and Testing Institute Plzen (former ŠKODA Výzkum). Neither of those focuses on research into metallic materials. COMTES FHT a.s. pursues long-term cooperation with the University of West Bohemia (UWB) in training new researchers and in joint projects, such as FORTECH (Research Centre of Forming Technology). The collaboration with UWB will become even more intensive in the WBCMM. The activities of WBCMM do not overlap in any respect with those of the Research and Testing Institute Plzen. The WBCMM Centre will be the only centre in the West Bohemia region focusing exclusively on R&D of new metallic materials, their processing and application in industry. It will offer comprehensive and superior services with high added value:

- Custom research and development – from literature and patent search through laboratory research to pilot production
- Information services, methodological know-how, expert reports
- Up-grading and transfer of technology
- Computer and physical modelling
- Testing of materials, measuring mechanical, physical and thermal characteristics
- Materials analysis, expert reports, materials consultancy
- Metallographic examination
- Forming and metal cutting
- Training students, doctoral students and researchers and continuous learning for specialist staff of industrial companies

6. HUMAN RESOURCES DEVELOPMENT

The project is tied directly to the National Development Plan of the Czech Republic. It will bring new jobs for research and development employees. As of 1st July 2014, WBCMM should be employing at least 55 members of staff, including 33 researchers (in positions of Heads, senior and junior staff) and 17 assistants. Over the course of the project implementation, at least 15 positions in research and development will be created, mostly for graduates with Master’s or PhD degrees, i.e. for young researchers under 35 years of age.

The employees will be the main source of the Centre’s know-how.
The project No. CZ. 1.05/2.1.00/030077 – the West-Bohemian Centre of Materials and Metallurgy – is funded from the Ministry of Education of the Czech Republic and from the structural funds of the EU under the Operational Programme Research and Development for Innovation, priority axis 2 - Regional R and D Centres.

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