Magnitogorsk State Technical University named after G.I. Nosov (MSTU), Russia

REPORT ON IMPLEMENTATION OF MMATENG PROJECT BY MESO ACTIVITY

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MSTU (P12)
Magnitogorsk, December of 2015
MMATENG work group of MSTU

Target institute, faculty and departments responsible for implementation of MMATENG project

- Metallurgy, Mechanical Engineering and Materials Processing Institute
- Standardization, Chemistry and Bioengineering Faculty
- Departments:
  - Foundry and Materials Science
  - Mechanical and Metallurgical Process Engineering
  - Ferrous Metallurgy
  - Technology, Certification and Service of Vehicles
  - Chemistry Department

Related universities and nonacademic partners involved in the project

- Novotroitsk Branch of the National University of Science and Technology MISiS
- LLC Research and Manufacturing Plant Foundry and Metallurgy Technologies
- OJSC MMK-METIZ
- CJSC MRK
- etc.

Novotroitsky filial

Новотроицкий филиал

Rudny industrial Institute, Rudny, Kazakhstan
Analysis of current curricula and disciplines related to the subject of MMATENG

<table>
<thead>
<tr>
<th>Items</th>
<th>BA</th>
<th>MA</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of current curricula in the field of MMATENG (total)</td>
<td>16</td>
<td>7</td>
</tr>
<tr>
<td>Number of curricula to be analyzed</td>
<td>11</td>
<td>4</td>
</tr>
<tr>
<td>Number of analyzed curricula</td>
<td>11</td>
<td>4</td>
</tr>
<tr>
<td>Number of curricula to be upgraded/modernized</td>
<td>11</td>
<td>4</td>
</tr>
<tr>
<td>Number of current disciplines in the field of MMATENG (total)</td>
<td>over 300</td>
<td>over 150</td>
</tr>
<tr>
<td>Number of disciplines to be analyzed</td>
<td>252</td>
<td>46</td>
</tr>
<tr>
<td>Number of analyzed disciplines</td>
<td>252</td>
<td>46</td>
</tr>
<tr>
<td>Number of disciplines to be upgraded/modernized</td>
<td>12</td>
<td>7</td>
</tr>
</tbody>
</table>

We have analyzed 15 current MMATENG related curricula containing 298 work programs and selected 23 disciplines included in licensed BA and MA educational program on “Metallurgy” and “Materials Science and Materials Engineering” for further upgrading.

We have developed a schedule of upgrading which provides for accreditation of developed educational programs and the schedule of their implementation (from February of 2015 to September of 2016) in training at 5 departments: Foundry and Materials Science; Mechanical and Metallurgical Process Engineering; Ferrous Metallurgy of the Institute of Metallurgy, Materials Science and Metal Working; Chemistry; Technology, Certification and Service of Vehicles of the Faculty of Standardization, Chemistry and Biochemistry.

An analytical report (35 pages, 5 tables) is issued.
List of disciplines to be upgraded and implemented in training at MSTU

The trial training – February 2016

Core curricula

1. Materials science
2. General materials science and materials engineering
3. Simulation and optimization of materials properties and processes
4. Constructional materials
5. Mechanics of materials and design principles
6. Modern structural and tool materials
7. Modern materials research methods
8. Modern methods of analysis of the structure and metal and alloy properties
9. Methods and tools for studies, analysis and diagnostics of nanomaterials
10. Mechanical properties of metals
11. Metallurgical and machine-building waste treatment
12. Processes and equipment for manufacturing of nanomaterials
13. Production waste treatment and disposal
14. Structure and properties of nanomaterials
15. Fundamentals of heat treatment processes at machinery plants
16. Fundamentals of heat treatment processes at metallurgical plants

Transferrable curricula

17. Innovations management
18. Quality management
19. Management and marketing
## The content of the discipline “Nano materials Technologies”

<table>
<thead>
<tr>
<th>Themes</th>
<th>Contact work hours</th>
<th>Time and tasks for individual work</th>
<th>Tasks</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Lect.</td>
<td>Practic. works</td>
<td>Laborat. works</td>
</tr>
<tr>
<td>1. General characteristics of nanotechnologies, nanomaterials and nanostructured materials</td>
<td>2</td>
<td>2</td>
<td>-</td>
</tr>
<tr>
<td>2. Techniques for synthesis and processing of nanomaterials and nanostructured materials</td>
<td>4</td>
<td>2</td>
<td>-</td>
</tr>
<tr>
<td>3. Basic research methods of nanomaterials nanostructured materials</td>
<td>6</td>
<td>2</td>
<td>8</td>
</tr>
<tr>
<td>4. Deformation methods of producing bulk nanostructured materials</td>
<td>6</td>
<td>2</td>
<td>-</td>
</tr>
<tr>
<td>5. Structure and mechanical properties of bulk nanostructured nanomaterials</td>
<td>6</td>
<td>2</td>
<td>8</td>
</tr>
<tr>
<td>6. Stability of bulk nanostructured nanomaterials to thermal influences</td>
<td>6</td>
<td>2</td>
<td>8</td>
</tr>
<tr>
<td>7. Application of nanomaterials and nanostructured materials</td>
<td>6</td>
<td>3</td>
<td>-</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>36</td>
<td>15</td>
<td>24</td>
</tr>
</tbody>
</table>

### Laboratory works themes:

1. "The evolution of structure and mechanical properties in the structure carbon steels during deformation nanostructuring by method of equal-channel angular pressing"
2. "The evolution of structure and mechanical properties after annealing of the structural ultrafine grained steel, nanostructured by method of equal-channel angular pressing"
3. "Modern diagnostics of the structure and properties and fisical modelling obteining of UFG structure in steels".
Title page and contents developed training manuals on discipline “Nano materials Technologies”

Nanomaterials Technologies
Notes and recommendations for the lecturers

Magnitogorsk State Technical University named after G.I. Nosov (MSTU), Russia

Kaptseva Natalia
Professor of Foundry and Materials Science Department

Polyakova Marina
Associate Professor of Mechanical and Metallurgical Process Engineering Department

20 October 2014

CONTENT

Introduction .................................................................................................................. 5
4 Deformation methods of producing bulk nanostructured materials. Torsion under high pressure: Equal-channel angular pressing. Screw extrusion. Comprehensive forging. Other methods based on large plastic deformation 37
5 Structure and mechanical properties of bulk nanostructured nanomaterials. Typical nanostructures and mechanism of structuring. Experimental methods for measuring grain growth. Peculiarities of mechanical properties formation in structural carbon steel in the process ECAP ................................................................. 46
6 Stability of bulk nanostructured nanomaterials to thermal influences. Behaviour of nanomaterials and the nanostructured materials when heating. Structural-phase transformations in low and medium carbon steel with UFG structure formed by the method ECAP ........................................................................................................ 61
7 Application of nanomaterials and nanostructured materials............. 70

79 pp.
The titles of tutorials prepared for publication under the project MMATENG

ATLAS
МИКРОСТРУКТУР
Учебное пособие

CТРУКТУРА И СВОЙСТВА НАНОСТРУКТУРИРОВАННЫХ УГЛЕРОДИСТЫХ КОНСТРУКЦИОННЫХ СТАЛЕЙ
Учебное пособие

Учебное пособие разработано в рамках проекта TEMПUS MMATENG «Модернизация двух циклов (MA, BA) учебных планов на основе компетенций в области материаловедения в соответствии с лучшим опытом Болонского процесса»

Магнитогорск 2015
The titles of methodical instructions to laboratory works (in English), developed under the project MMATENG

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**Microprobe Analysis**

Methodical instructions for laboratory works on discipline «Methods of materials investigation», «Advanced materials researches», «Methods of materials control and analysis» for students of technical specialties and directions of the University

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**Quantitative Analysis Percentage Ductile Fracture Component**

Methodical instructions for laboratory works on discipline «Methods of materials investigation», «Advanced materials researches», «Methods of materials control and analysis» for students of technical specialties and directions of the University

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**Study of Construction and Working Principles of the Scanning Electron Microscope**

Methodical instructions for laboratory works on discipline «Methods of materials investigation», «Advanced materials researches», «Methods of materials control and analysis» for students of technical specialties and directions of the University
<table>
<thead>
<tr>
<th>№</th>
<th>Discipline description at MSTU</th>
<th>Curriculum. Program / Profile of training</th>
<th>Degree</th>
<th>Target Department</th>
</tr>
</thead>
</table>
| 1  | Materials science                                                                           | 150400.62. Metallurgy / Metal Science and Heat Treatment of Steel and High-Strength Alloys  
150400.62. Metallurgy / Foundry Process  
221700.62. Standardization and Metrology / Standardization and Certification                                             | BA     | FMS, MMPE, FM, TCSV |
| 2  | General materials science and materials engineering                                          | 150100.62. Materials Science and Materials Engineering / Materials Science and Materials Engineering (in machinery)  
150100.62. Materials Science and Materials Engineering / Materials Science and Nanomaterials and Nanosystem Engineering | BA     | FMS, MMPE          |
<p>| 3  | Simulation and optimization of materials properties and processes                            | 150100.62. Materials Science and Materials Engineering / Materials Science and Materials Engineering (in machinery)         | BA     | FMS              |
| 4  | Selection of heat treatment technologies and equipment                                       | 150100.62. Materials Science and Materials Engineering / Materials Science and Materials Engineering (in machinery)         | BA     | FMS              |
| 5  | Operational materials                                                                       | 190600.62. Operation of Handling and Production Machines and Complexes / Automotive Service                                  | BA     | TCSV             |
| 6  | Mechanics of materials and design principles                                                | 150100.62. Materials Science and Materials Engineering / Materials Science and Nanomaterials and Nanosystem Engineering    | BA     | MMPE             |
| 7  | Modern structural and tool materials                                                        | 150400.68. Metallurgy / Metal Science and Metal Heat Treatment                                                              | BA     | FMS              |
| 8  | Modern materials research methods                                                           | 150400.68. Metallurgy / Metal Science and Metal Heat Treatment                                                              | MA     | FMS, MMPE        |
| 9  | Modern methods of analysis of the structure and metal and alloy properties                   | 221700.68. Standardization and Metrology/ Tests and Certification                                                            | MA     | TCSV             |</p>
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<tr>
<td>9</td>
<td>Methods and tools for studies, analysis and diagnostics of nanomaterials</td>
<td>150100.62. Materials Science and Materials Engineering / Materials Science and Nanomaterials and Nanosystem Engineering</td>
<td>BA</td>
<td>MMPE</td>
</tr>
</tbody>
</table>
| 10 | Mechanical properties of metals                                                                 | 150400.62. Metallurgy / Metal Science and Heat Treatment of Steel and High-Strength Alloys  
150100.62. Materials Science and Materials Engineering / Materials Science and Materials Engineering (in machinery) | BA     | FMS               |
| 11 | Metallurgical and machine-building waste treatment                                             | 150400.68. Metallurgy / Ferrous Metallurgy                                                                | MA     | FM                |
| 12 | Production waste treatment and disposal                                                         | 280700.62. Technosphere Safety / Technosphere Safety                                                     | BA     | Chemistry         |
| 13 | Processes and equipment for manufacturing of nanomaterials                                     | 150100.62. Materials Science and Materials Engineering / Materials Science and Nanomaterials and Nanosystem Engineering | BA     | MMPE              |
150400.62. Metallurgy / Metal Forming (metalware production) | BA     | MMPE              |
| 15 | Fundamentals of heat treatment processes at machinery plants                                   | 150400.62. Metallurgy / Metal Science and Heat Treatment of Steel and High-Strength Alloys               | BA     | FMS               |
| 16 | Fundamentals of heat treatment processes at metallurgical plants                               | 150400.62. Metallurgy / Metal Science and Heat Treatment of Steel and High-Strength Alloys               | BA     | FMS               |

**Transferrable curricula**

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<th>Curriculum. Program / Profile of training</th>
<th>Degree</th>
<th>Target Department</th>
</tr>
</thead>
<tbody>
<tr>
<td>17</td>
<td>Innovations management</td>
<td>150400.68. Metallurgy / Ferrous Metallurgy</td>
<td>MA</td>
<td>FM</td>
</tr>
</tbody>
</table>
| 18 | Quality management                                               | 150400.68. Metallurgy / Metalware Production  
150400.68. Metallurgy / Ferrous Metallurgy | MA     | FMS               |
| 19 | Management and marketing                                         | 261700.62. Graphic Arts and Packaging Technology / Packaging Technology and Design   | BA     | Chemistry         |
Establishing the Materials Information Technology Lab (MITL) and Material Engineering Service Office (MESO)

Plan of key activities

- To prepare a room for MITL and MESO
- To procure and study opportunities of MITL equipment
- To prepare work schedules of MESO and MITL
- To develop an individual page of MESO and MITL on the website of the university
- To analyze potential services, offered to partner companies, using MITL
- To send information emails inside the university and to interested organizations
- To carry out introductive seminars and a presentation of potential opportunities of MITL for groups of students
- To monitor research projects of students and workgroups showing a potential interest in the use of MITL
- To develop a draft Regulation on MESO
List repair works:

1. Water-emulsion paint of the ceiling;
2. Pasting wallpaper for painting;
3. Linoleum floor covering;
4. Installation of wooden plinths;
5. Installation of PVC window;
6. Installation of wooden door;
7. Two sides painting of door;
8. Installation the cable channel and cabling;
9. Installation of outlets;
10. Installation of one-button switch;
11. Installation of shutters;
12. Preparation of 3 workplace and installation of one of them.
Room for MITL
Available equipment for practical lessons:

1. Universal testing machines for tension, compression, torsion.
2. Brinell and Rockwell hardness testing devices
3. Working model a section rolling mill
4. Scanning zond microscope
5. Chamber furnace
6. Drawing mill
7. Rolling mill
1. Simulation and study of molecules properties
2. General Atomic and Molecular Electronic Structure System (Hartree-Fock method, density functional theory, valence bond theory and etc.)
3. Design and study of supramolecules properties
4. Simulation and study of the properties of nanoparticles
5. Modeling of microstructure by close packing of spheres
6. Modeling of sintering processes
7. Modeling of nanoparticle self-organization
8. Simulation of diffusion processes in the membranes
9. Modeling of pore space permeability
Laboratory of computer simulations

Scanning zond microscopy
Laboratory equipment

Plan for the purchase of equipment:
1. H600 AM Metallurgical Microscope with Image analysis software
2. 3D Printer Picasso Designer
3. 3D Scanner RangeVision Smart
4. Anti-vibration table for SZM
Thank you for your attention!