



ЦЕНТЪР ЗА ОБУЧЕНИЕ – БАН

1000 София
ул. „Сердика“ № 4
<http://edu.bas.bg>

email: tdc-phd@cu.bas.bg
тел.: 02 987 31 67
02 979 52 60

Basic Information:

Course Title: Functional coatings and surface technologies for industrial applications: design, characterization and optimization for marine environment, energy and mechanical engineering

Lecturer: Assoc. Prof. Deyan Veselinov, PhD

Phone: 0896 113 999

Email: dveselinov@ims.bas.bg

Total Teaching Hours: 30

Annotation:

The course provides advanced knowledge and practical skills for the design, deposition, and characterization of functional coatings for industrial applications in marine environments, energy systems, and mechanical engineering. It covers technologies such as plasma powder spraying, selective deposition, anodizing, laser processing, and hybrid approaches aimed at developing coatings with anticorrosion, antifouling, antibacterial, hydrophobic, and wear-resistant properties.

Emphasis is placed on the relationships between processing parameters, microstructure, and functional performance, using modern techniques for morphological, phase, mechanical, and electrochemical analysis. The course also includes modules on experimental data processing and environmental sustainability assessment in accordance with life cycle assessment (LCA) principles and European regulations.

Through laboratory work and application-oriented case studies, students develop skills in experimental design, critical analysis, and preparation of doctoral-level research in the field of functional coatings.

Course content

1. Classification of surface technologies – thermal, chemical, mechanical, and hybrid methods.
2. Role of surface coatings in mechanical engineering, energy, and marine industries – advantages and requirements.
3. Plasma powder spraying (PPS) – principles, equipment, process parameters, and coating examples.
4. Structure and properties of PPS coatings – influence of parameters on porosity, adhesion, and microhardness.
5. Comparative analysis of thermal spray technologies – HVOF, PPS, flame spray – characteristics and applications.
6. Effect of post-deposition heat treatment on coating properties.
7. Anodizing of aluminum and its alloys – mechanisms, structures (barrier and porous layers), applications.
8. Anodizing of titanium and its alloys – process parameters, oxide layers, and functionality.
9. Selective electrodeposition (brush plating) – process, equipment, and industrial applications.
10. Electroplated coatings for protection and decoration – types, adhesion, and thickness control.
11. Nitriding of steels and alloys – thermodynamics, microstructural zones, applications.
12. Cyanide carburizing/nitrocarburizing and boriding – diffusion processes, phase formation, hardness evolution.



ЦЕНТЪР ЗА ОБУЧЕНИЕ – БАН

1000 София
ул. „Сердика“ № 4
<http://edu.bas.bg>

email: tdc-phd@cu.bas.bg
тел.: 02 987 31 67
02 979 52 60

13. Comparison between diffusion and deposition technologies – advantages, limitations, wear and corrosion resistance.
14. Laser surface melting and cladding – mechanisms, microstructural changes, properties.
15. Laser alloying of metals – surface interaction, penetration depth, effect on strength and wear resistance.
16. Hybrid technologies – synergistic effects and industrial applications.
17. Microstructural characterization methods – SEM, EDS, optical microscopy – principles and interpretation.
18. Phase analysis by XRD – fundamentals, diffraction pattern analysis, stress and phase identification.
19. Microhardness measurement and gradients in coatings – methods and structural influence.
20. Surface roughness measurement, profilometry, and 3D visualization – parameters and functional correlations.
21. Contact angle measurement and hydrophobicity – methods and relevance for corrosion protection.
22. Electrochemical testing (OCP, EIS, Tafel) – principles, results, and structure–property relationships.
23. Cavitation erosion – methodology and interpretation in marine environments.
24. Tribological testing – dry friction, lubricated contacts, and tribocorrosion.
25. Correlation between morphology, phase composition, and wear/corrosion behavior.
26. Fundamentals of design of experiments (DOE) for surface technologies.
27. Influence of process parameters on performance – case studies from marine and energy industries.
28. Criteria for selecting appropriate surface technologies for specific industrial applications.
29. REACH, RoHS, and related regulations – constraints and guidelines for materials and processes.
30. Sustainability and environmental impact assessment of surface technologies – green process concepts.

Teaching and assessment methods

- Lectures with multimedia presentations and interactive discussions
- Practical laboratory exercises
- Independent study of scientific publications and case study analysis
- Development and presentation of an individual or group research project

Assessment:

- Continuous assessment (participation and assignments) – 20%
- Laboratory reports – 30%
- Project/presentation – 50%

Competencies acquired as a result of training

- Ability to select and optimize surface technologies for specific industrial applications
- Skills in analysis and interpretation of microstructure, phase composition, and performance of coatings



ЦЕНТЪР ЗА ОБУЧЕНИЕ – БАН

1000 София
ул. „Сердика“ № 4
<http://edu.bas.bg>

email: tdc-phd@cu.bas.bg
тел.: 02 987 31 67
02 979 52 60

- Competence in applying modern characterization techniques (SEM, EDS, XRD, electrochemical methods)
- Ability to design experiments (DOE) and process scientific data
- Skills in critical analysis and development of research hypotheses in the field of functional coatings

Literature:

1. Metals Handbook, Vol. 5: Surface Engineering (ASM International)
2. Surface Engineering for Corrosion and Wear Resistance – J. R. Davis (ASM International, 2001).
3. Handbook of Deposition Technologies for Films and Coatings – P. M. Martin (Elsevier, 2010).
4. Modern Surface Engineering Treatments – M. S. J. Hashmi (Springer, 2013).
5. Thermal Spray Fundamentals: From Powder to Part – R. C. Tucker Jr. (Springer, 2014).
6. Principles of Thermal Spray Coatings – T. Fauchais, J. Vardelle (Springer, 2016).
7. Laser Surface Engineering: Processes and Applications – J. Lawrence, (Woodhead, 2014).
8. Nitriding and Nitrocarburizing – G. Krauss (ASM Handbook, Vol. 4D, 2014).
9. Boronizing and Surface Diffusion Treatments – chapter in *Surface Modification of Steels* (Springer, 2019).
10. Anodic Oxidation of Aluminium and Its Alloys – J. W. Diggle (Pergamon, 1979)
11. Electroplating and Surface Treatment of Metals – N. Kanani (Elsevier, 2004).
12. Surface Treatments for Protection against Wear – C. P. Dillon (ASM, 2002).
13. Materials Characterization: Introduction to Microscopic and Spectroscopic Methods – Y. Leng (Springer, 2013).
14. X-ray Diffraction: A Practical Approach – C. Suryanarayana (CRC Press, 1998).
15. Scanning Electron Microscopy and X-ray Microanalysis – J. I. Goldstein et al. (Springer, 2017).
16. Mechanical Testing of Materials – A. H. Cottrell (Butterworth-Heinemann)
17. Marine Corrosion and Prevention of Metallic Materials – D. A. Jones (Wiley, 1992).
18. Corrosion Protection and Control Using Nanomaterials – V. S. Saji, R. Cook (Woodhead, 2012).
19. Статии в *Wear, Surface & Coatings Technology, Journal of Thermal Spray Technology, Corrosion Science*.
20. REACH and RoHS: A Guide to European Chemical Regulations – Springer Briefs in Applied Sciences and Technology.
21. Green Surface Engineering and Tribology – M. Aliofkhazraei (Elsevier, 2019).
22. Документи от ECHA (European Chemicals Agency) – актуалните изисквания за REACH/RoHS.

Additional information:

Prerequisites: Materials science, physics of materials, corrosion and corrosion protection



ЦЕНТЪР ЗА ОБУЧЕНИЕ – БАН

*1000 София
ул. „Сердика“ № 4
<http://edu.bas.bg>*

*email: tdc-phd@cu.bas.bg
тел.: 02 987 31 67
02 979 52 60*

Requirements: Active participation in laboratory sessions and preparation of scientifically sound reports

Recommended: Basic skills in working with specialized data analysis software