SURFACE ENGINEERING FOR CORROSION AND WEAR RESISTANCE APPLICATION

PROF. INDRANIL MANNA
Department of Metallurgical and Materials Engineering
IIT Kharagpur

PROF. JYOTSNA DUTTA MAJUMDAR
Department of Metallurgical and Materials Engineering
IIT Kharagpur

INTENDED AUDIENCE: Metallurgical Engineering, Mechanical Engineering, Materials Science and Physics

PREREQUISITES: Materials Science and Engineering

INDUSTRIES APPLICABLE TO : Tata Steel, Jamshedpur, Tata Metallics, Kharagpur, R&D Center for Iron and Steel (RDCIS), Ranchi, Engineers from all the Integrated Steel Plants under Sail Authority of India Limited.

COURSE OUTLINE : Wear and corrosion are the major causes of degradation of engineering components for structural applications. Among different ways of minimizing the probability of failure of components by wear or corrosion or improving its lifetime is by optimum designing of surface, may be termed as surface engineering. However, the properties achieved on the surface depend on the techniques to be applied, process parameters to be chosen and the surface characteristics (surface roughness, microstructure and composition) achieved thereafter. The present course encompasses (a) a brief introduction to the wear and corrosion and their classification, (b) surface microstructure and composition required for combating different modes of wear and corrosion, (c) classification and scopes of surface engineering, (d) principle of different modes of surface engineering, process parameters, advantages and disadvantages, (e) characterization and testing of surfaces and (f) engineering applications of surface engineering techniques. The course will offer training to the engineering students pursuing studies in the UG and PG level from Metallurgical engineering, mechanical engineering, materials science, physics and chemistry.

ABOUT INSTRUCTOR : Prof. Indranil Manna, a JC Bose fellow and Institute Chair Professor at IIT Kharagpur, is an educationist and materials engineer with wide ranging teaching and research interests concerning structure property correlation and modeling in structural and functional materials including nanometric metals, laser/plasma assisted surface engineering, nano-fluid and bainitic steel. His work on amorphous Al-alloys, laser surface engineering of steel/Mg/Al alloys, and thermal conductivity of nanofluid are highly cited. His teaching interest covers subjects related to physical metallurgy, phase transformations, material characterization and surface engineering. Besides IIT Kharagpur (1985-present), Professor Manna has taught in Nanyang Technological University, Singapore (2000 01) and IIT Kanpur (2013-17). He developed two new courses (Surface engineering and Introduction to Engineering Solids) during his career. Surface engineering is available in SWAYAM platform. As an active researcher, he visited different renowned Institutions and Universities abroad like Max Planck Institute at Stuttgart, Technical University of Clausthal, Liverpool University, Nanyang Technological University and University of Ulm as a guest scientist. Prof Manna has authored over 250 journal publications and several patents, edited a number of books and monographs, supervised 25 PhD theses and over 30 sponsored projects worth over Rupees 200 million at IIT-Kharagpur and received several national/international awards and recognition.

Prof. Jyotsna Dutta Majumdar is serving for the Department ofMetallurgical and Materials Engineering, Indian Institute ofTechnology Kharagpur as Professor. Her areas of specializationinclude the following: (a) surface engineering, (b) surface modification and coating technology, (c) advanced materials processing and (d) corrosion and environmental degradation. She is well known internationally for her research contribution in the field of Metallurgical and Material Engineering with focus on surface engineering and laser surface processing. She made fundamental contributions to a profound understanding of the metallurgy of rapid solidification of metals under the specific heat input of a laser source. Her works also concern a detailed structure-property correlation of laser surface modified metallic materials with a specific goal to improve certain engineering properties. She also stated a brief understanding of the mechanism of wear, corrosion and high temperature oxidation of the metastable microstructures developed in commercial metals and alloys due to laser processing. Extensive efforts were also made for the first time for the development of compositionally graded surface and nano-dispersed surface for thermal barrier and hot corrosion application by application of hybrid coating technology.

COURSE PLAN :

Week 1: Introduction to materials, surface, thermodynamics of surface, surface dependent engineering properties

Week 2: Common surface initiated engineering failure; mechanism of surface degradation (wear, corrosion and high Temp. Oxidation).

Week 3: Role of microstructure and materials behavior in controlling the surface dependent failure of components, importance of surface engineering, classification and scope of surface engineering of Materials. Introduction to surface modification and coating techniques.

Week 4: Conventional surface modification methods: flame hardening, induction hardening, carburizing, nitriding, diffusion assisted surface alloying.

Week 5: Advanced surface modification methods: Laser, Plasma and electron beam assisted surface modification.

Week 6: Surface Coating by Chemical/electro-chemical Routes Electro/electroless deposition, anodizing, micro-arc oxidation

Week 7: Surface Coating by Physical Routes: Physical vapor deposition (Thermal evaporation, sputtering and Ion Plating), pulsed laser deposition, cathodic arc evaporation.

Week 8: Surface Coating by chemical Routes: Chemical vapor deposition, laser assisted chemical vapor deposition.

Week 9: Hot dipping, (galvanizing, tinning, aluminizing, babitting, etc.)

Week 10: Thermal Spraying (flame spraying, HVOF spraying, wire arc spraying, kinetic spraying)

Week 11: Weld overlaying, laser surface cladding

Week 12: Surface characterization and Testing