



CARBON MATERIALS AND MANUFACTURING

SWATI SHARMA

Department of School of Engineering
IIT Mandi

TYPE OF COURSE : New | Elective | PG

COURSE DURATION : 12 weeks (18 Jan' 21 - 09 Apr' 21)

EXAM DATE : 24 Apr 2021

PRE-REQUISITES : Material Science for Engineers -OR- Structure of Materials (any basic material science course with description of crystal systems taught at UG level)

INTENDED AUDIENCE : Advanced B.Tech./ M.Tech. M.E./ Ph.D. from materials/ manufacturing/ energy sciences

INDUSTRIES APPLICABLE TO : This course is of high industrial relevance. All companies manufacturing carbon-fiber composites, as well as other carbon materials will benefit.

COURSE OUTLINE :

This course is focused on the preparation and structure-property relationship of various carbon materials for the purpose of device manufacturing. The contents are designed in a such a way that each type of carbon is taught in a material-manufacturing pair. Topics pertaining to the properties of various carbon allotropes, crystallinity and hybridization, raw materials, carbon fibers and composites, carbon nanomaterials and bulk industrial carbons will be covered.

ABOUT INSTRUCTOR :

Dr. Swati Sharma is currently an Assistant Professor in the School of Engineering at the Indian Institute of Technology (IIT), Mandi, India. Prior to this, she worked as a scientist at the Karlsruhe Institute of Technology and the University of Freiburg, Germany. She obtained her M.S./ Ph.D. from the University of California, Irvine, USA in 2013 in the field of carbon-based miniaturized sensors. She completed her Bachelors degree in chemical engineering from the Birla Institute of Technology and Science, Pilani, India, and worked a research scientist at the Ranbaxy Research Laboratories. Her primary research area is carbon-based devices, including biosensors, flexible electronics and bioelectronic medicine. She has expanded her research to industrial carbon manufacturing and obtaining high-value device friendly carbon materials from the urban solid waste. Her research work has been published in various peer-reviewed journals and books. She currently teaches various materials, manufacturing and energy systems related courses at IIT Mandi.

COURSE PLAN :

Week 1: Introduction to carbon (carbon economy, atomic structure and hybridization, carbon allotropes, nomenclature and terminology)

Week 2: Bulk industrial carbon (graphite: natural and pyrolytic, activated carbon, glass-like carbon, granular amorphous carbon)

Week 3: Carbon fibers and composites (activated carbon fiber, carbon fiber reinforced plastics, carbon fiber composite manufacturing techniques)

Week 4: Carbon nanomaterials (graphene, carbon nanotube, fullerene, graphite whiskers, diamond-like carbon)

Week 5: Physics of carbon devices (graphene and carbon nanotube based carbon devices)

Week 6: Raw materials (polymer precursors: Polyacrylonitrile, cellulose, resins, PVC etc.; needle coke, coal and its distillation, gaseous hydrocarbons for CVD)

Week 7: Manufacturing techniques for carbon materials - I (pyrolysis, electrospinning, chemical vapor deposition)

Week 8: Manufacturing techniques for carbon materials - II (composite preparation, material/ binder interface)

Week 9: Testing methods for mechanical, physical and thermal properties (density, hardness, porosity, electrical resistivity, flexural strength, compressive strength, tensile strength, thermal expansion, modulus of elasticity, ash/ moisture content)

Week 10: Applications (graphite electrodes, carbon-based micro and nano devices: sensors, microelectrodes etc., filters and adsorbers)

Week 11: Examples from carbon-fiber industry and supply chain of carbon fibers (Sports and apparels, Aeronautics and space, Nuclear industries, Heavy Engineering Industry, High volume applications: wind energy and Automotive, Structural and civil Engineering applications, Environmental/Energy Plants)

Week 12: Special topics (health and environmental safety of carbon nanomaterials, carbon-based flexible electronics, future of carbon technology)