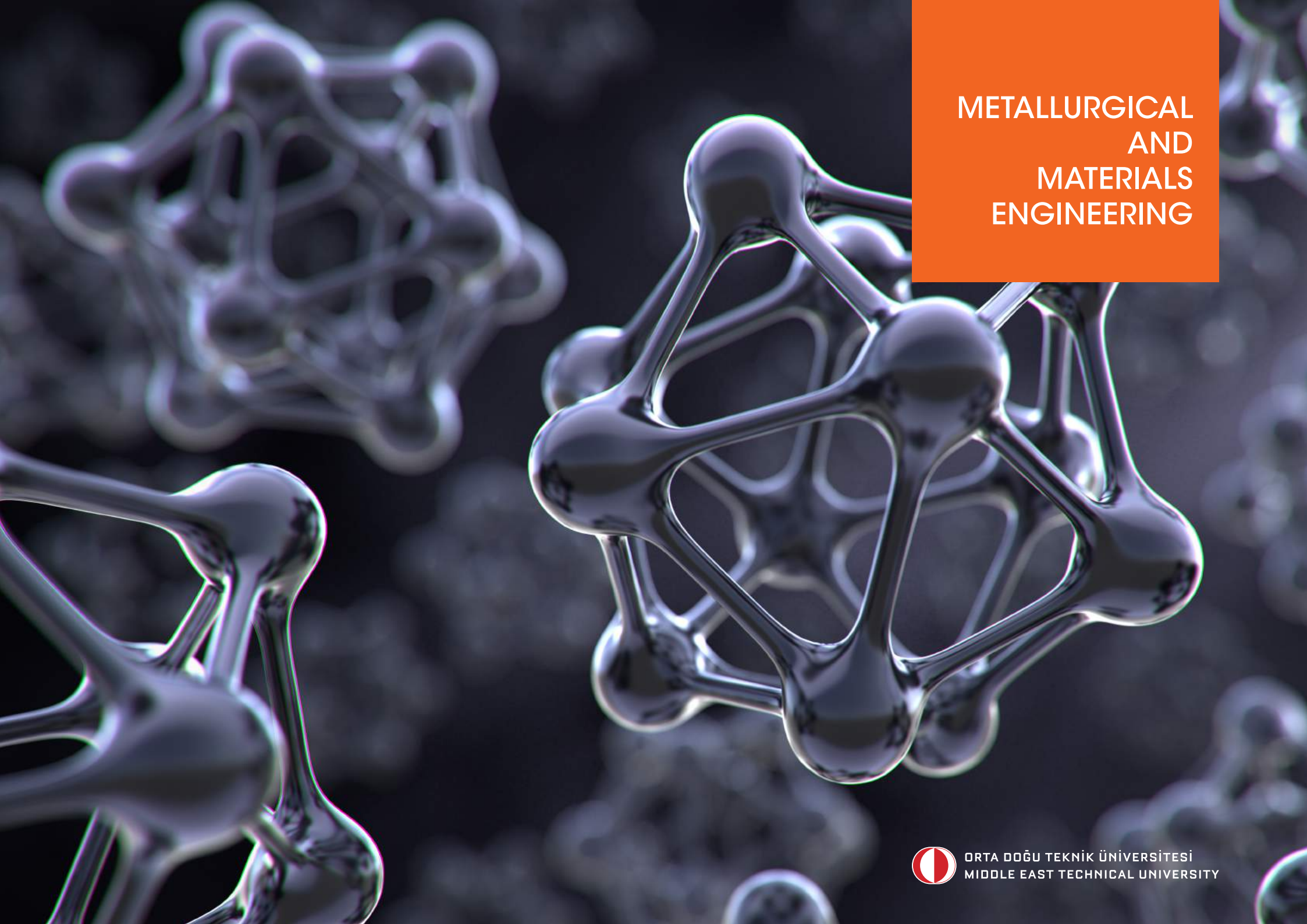


METALLURGICAL AND MATERIALS ENGINEERING

ORTA DOĞU TEKNİK ÜNİVERSİTESİ
MIDDLE EAST TECHNICAL UNIVERSITY

METALLURGICAL AND MATERIALS ENGINEERING

The mission of Department of Metallurgical and Materials Engineering at METU is to educate engineers and researchers with universal qualifications that can meet the needs and expectations of the industry and lead them in their development and to contribute to the transformation of the produced knowledge and technologies into social welfare by carrying out research that can respond to the changing needs of the country in matters of interest.

Content

Message from the Chair

METU Department of Metallurgical Engineering was found in 1966; and parallel to the changes in the world, in 1995, it was renamed as METU Department of Metallurgical and Materials Engineering. The department has celebrated its 50th anniversary in 2016. Since the day the department was established, we have been contributing to our national interests and the world's scientific community with its well-educated graduates and cutting edge research. In the Department, all faculty members have intenationally proven academic skills. Our department has an ABET-accredited undergraduate program since 1995.

METU Department of Metallurgical and Materials Engineering is accepting undergraduate applications with the highest percentile in the nationwide university entrance examination in its academic field. Each year, 82 students have the privilege to start their bachelor's degree in this department. In 2020, the mathematics and science scores of students joining our program ranged from 1,715th to 18,948th among about 1,880,000 candidates.

Metallurgical and materials engineering overlaps with all engineering fields and applications. All industries, one way or another, need to deal with materials on a daily basis. Many of engineering problems stem from the limitations of properties and performances of available materials. Therefore, our alumni have a wide and expanding spectrum of job opportunities: they easily find positions in major national and international companies, research institutes, or can launch their own start-up ventures. Furthermore, the continual need to develop advanced materials and products with innovative features provides our graduates to obtain positions in high technology fields, i.e. concept development and design, computer aided modeling and simulations, research and development. Besides, our graduates are accepted into the top graduate schools across the globe.

METU Metallurgical and Materials Engineering Department is internationally recognized, and is a pioneer and a leader department in its field in Turkey. Our department, consisting of internationally recognized academicians, has a strong infrastructure available for both undergraduate and graduate education. In addition to the common research and characterization laboratories of the department, the faculty members hold their own research laboratories specialized to their area of research. The research studies conducted in our department include nanotechnology, biomaterials and nanomedicine, surface science, coatings and thin films, electromagnetic materials, energy storage devices and batteries, novel alloys design and development, photocatalytic materials, polymers, nanocomposites, functional and smart materials, colloid science, thermochemical and electromechanical materials, electrometallurgy, materials chemistry, casting, metal forming, heat treatment, welding, non-destructive testing, and multi-scale simulation.

Prof. C. Hakan Gür

About Us

The department was found in 1966 as METU Department of Metallurgical Engineering; and parallel to the changes in the world, in 1995 it was renamed as METU Department of Metallurgical and Materials Engineering. In 1963, with the request of Prof Dr Mustafa Parlar, the Dean of Engineering, Dr. Mustafa Doruk from mechanical engineering department and Prof. Ariel Taub (Technion-Israel) began putting efforts to start the Metallurgical Engineering Department. In 1964, core faculty of the department was recruited. In the same year, 11 volunteers from the sophomore year of Mechanical Engineering established the first class of Metallurgical Engineering.

On June 30th 1966, METU Board of Trustees decided to establish the Department of Metallurgical Engineering. Until the department began using government funds for buildings and equipment in 1972, UNESCO, AID and CENTO funds had been used for the laboratories and the main research projects.

From 1965 to 1973, academicians from Sweden (Dr. Hermann Unckel), Norway (Dr. Terkel Rosenqvist), UK (Dr. John Critchley, Dr. Jeffrey Taylor) and USA (Dr. Mario Gomez, Dr. John Shyne) sent by UNESCO, AID and CENTO helped founding and developing the department. With the support of METU president Kemal Kurdas, faculty requirements were determined and research assistants were channeled to obtain their doctorates. In addition, some of the initial graduates of the program were hired as academic staff in the department after completing their PhD studies abroad.

In 2009, some critical changes were introduced, mainly with regard to the Capstone Design Course, and new elective courses promoting undergraduate involvement in research project. Both of these emphasize a one-to-one relationship between the faculty and the students. Meanwhile, new technical electives on contemporary topics were offered in the curriculum after recent hires of young new faculty. In addition, the Materials Processing Laboratory course was added to the program in 2011, to improve the practical processing knowledge of the students and there has been a continuous interest and effort in incorporating computational techniques and methods in the coursework.

Continual advancement of materials, which contain one or more of the main material groups, which are metal, ceramic, and polymer, has led to new applications and technologies in all engineering fields, particularly in electronics, nano-technology, bio-technology. Another important development is in the fields of computational material design and process simulations. Our department has remarkably revised the undergraduate curriculum by closely following and analyzing these developments. The new curriculum is valid for students starting their first semester of their freshman year as of 2017-2018 academic year.

Majority of the our graduates are employed just after their graduation. Our graduates are preferred in advanced and traditional material technologies, material products and process development fields; are working efficiently and effectively in priority areas such as defense, energy, transportation and nano- and bio-technology; are preferred as an engineer and researcher in leading and important private and state institutions; following graduation, they are continuing their education in the relevant engineering and science departments of respected universities and have successful academic careers both in national and international level; are distinguished as a leader and expert in their careers and professional engineers who contribute to professional organizations in the professional field and participate in continuous training events.

Facts and Figures

Founded in 1966

Duration of Study
Bachelor 4 years
Master 2 years
Doctor of Philosophy 4 years

FULL-TIME FACULTY
14 Professors
2 Associate Professors
5 Assistant Professors

Students
470 Undergraduate
210 Graduate
16 Inernational
11 Minor
3 Double Major

COURSE CREDITS
147 Undergraduate
21 Graduate

PROJECTS & PUBLICATIONS
1 National Project

7 TUBITAK Projects
Total budget of 12.000.000 TL
260 Articles (last 5 years)
250 of in international journals
10 of in national journals

DEGREES
3250 B.Sc.
772 M.Sc.
94 Ph.D.

Undergraduate Curriculum

The Department of Metallurgical and Materials Engineering is concerned with the generation and application of knowledge on engineering materials. It comprises such aspects as the extraction and refining processes, synthesis and processing of materials, factors affecting the internal structure of solids, methods of altering the structure and
properties of materials and factors affecting the materials behavior in service. Materials are crucial in all other fields of engineering, since innovations in materials often lead to improvements in design or sometimes to the emergence of brand new products. In short, most fields of work or study have a bit of metallurgy and materials in them!

Materials of concern are metals and alloys, ceramics, glasses, polymers and their composites. The undergraduate curriculum comprises a core program that emphasizes principles basic to all these classes of materials. It builds upon courses on physics, chemistry and certain aspects of solid mechanics with a series of courses on internal structure of solids covering both chemical and physical aspects and structure-property relations.

The core program is also gives fundamentals of scientific computing and a large variety of simulation techniques used materials engineering to cover all possible length and timescales from atomistic to mesoscopic and macroscopic scales, on the introductory level. From the fifth semester on, the core curriculum addresses to career opportunities in metallurgical and materials engineering. These include the metal industries, ceramic industries and other small/medium scale industries that normally deal with a variety of materials. Energy, automotive, aerospace and defense industries, iron and steel plants, non-ferrous industries, foundries, heat treatment shops, ceramic and glass industries, research institutions are some examples for the employment opportunities. The Metallurgical and Materials Engineering undergraduate program was accredited by the Engineering Accreditation Commission of ABET, http://www.abet.org (1996, 2004, 2009 and 2015).

Course Descriptions

METE102 Introduction to Metallurgical and Materials Engineering (2-0)2
Historical perspective of materials in the service of mankind and civilization. Development of metals, alloys, ceramics, polymers, and composites. Production, processing, properties and performance of conventional and modern materials. Domestic and international activities in metallurgical and material industries.

METE201 Materials Science I (3-0)3
Classification of materials and properties. Atomic theory and atomic bonding in solids, the structure of crystalline and non-crystalline materials; atomic coordination and packing, structure types in crystalline solids, amorphous materials. Imperfections in solids, point, line and surface defects. Phase equilibria, one and two-component systems. Atom movements and diffusion. Phase transformations: concepts of driving force, nucleation, growth and TTT curves.

METE202 Materials Science II (3-0)3
Introduction to properties of materials. Mechanical behavior of solids: Elasticity, theoretical strength, plastic deformation, fracture, creep, fatique, viscosity, viscoelasticity. Thermal properties of materials: Thermal conductivity, thermal expansion, thermoelectricity. Electronic properties, optical properties, magnetic properties and chemical properties.

METE203 Thermodynamics of Materials I (3-0)3
Concepts and definitions. First law of thermodynamics; internal energy, heat and work, heat capacities, enthalpy and applications to material processing. The second law of thermodynamics; heat engines Carnot cycle, entropy concept . The third law of thermodynamics. Auxiliary thermodynamic functions, Gibbs and Helmholtz energies, Maxwell relations. Equilibrium. Reaction equilibria in gas mixtures.

METE204 Thermodynamics of Materials II (3-0)3
Reaction equilibria between condensed materials and a gaseous phase, Oxidation of metals and Ellingham diagram, Solution thermodynamics, partial and integral molar quantities, Gibbs-Duhem equation, relative partial and relative integral molar quantities. Microscopic examination of solutions, ideal non-ideal solutions, excess properties. Gibbs-Duhem integration. Applications to materials systems. Reaction equilibria in solutions.

METE206 Materials Laboratory (1-2)2
Mechanical testing; tensile testing, impact testing and hardness. Heat treatment and microstructures; annealing, quenching and tempering of steel. Crystallography and X-ray diffraction; phase identification. Temperature measurement. Calorimetry. Physical property measurement.

Undergraduate Curriculum

First Semester

PHYS 105	General Physics I	(3-2)4
CHEM 111	General Chemistry I	(3-2)4
MATH 119	Calculus with Analytical Geometry	(4-2)5
ME 105	Computer Aided Engineering Graphics	(3-0)3
ENG 101	English for Academic Purposes I	(4-0)4
IS 100	Introduction to Information Technologies and App.	NC
OHS101	Occupational Health and Safety I	NC

Second Semester

PHYS 106	General Physics II	(3-2)4
CHEM 112	General Chemistry II	(3-2)4
MATH 120	Calculus for Functions of Several Variables	(4-2)5
METE 102	Introduction to Metallurgical and Materials Engineering	(2-0)2
ENG 102	English for Academic Purposes II	(4-0)4
BA 100	Career Planning	NC

Third Semester

MATH 219	Introduction to Differential Equations	(4-0)4
METE 201	Materials Science I	(3-0)3
METE 203	Thermodynamics of Materials I	(3-0)3
METE 215	Materials Processing Laboratory	(1-2)2
CENG240	Programming with Python For Engineers	(2-2)3
ENG 211	Academic Oral Presentation Skills	(3-1)3
OHS 301	Occupational Health and Safety II	NC
Any 1 of the following set...		
HIST 2201	Principles of Kemal Atatürk I	NC
HIST 2205	History of the Turkish Revolution	NC

Course Descriptions

METE215 Materials Processing Laboratory (1-2)2
Fundamentals of materials processing. Laboratory experiments and data analysis in materials processing. Particle size reduction and analysis, fabrication of ceramics by pressing and firing, sol-gel processing of ceramics, polymer compounding and shaping, roasting of a copper sulfide concentrate, leaching and electrowinning, solidification of materials and mechanical shaping of materials.

METE230 Fundamentals of Materials Science and Engineering (3-0)3
Fundamentals of materials processing. Laboratory experiments and data Introduction and classification of materials; structure of metals, ceramics and polymers, imperfections; diffusion; phase diagrams and microstructure; materials properties: mechanical, electrical, magnetic, optical and chemical; composite materials.

METE300 Summer Practice I (Non-Credit)
Summer practice of at least 21 working days preferably carried out in a plant that will involve processing of materials in an integrated manner. Report prepared at the end of summer practice should reflect both the practical experience and the knowledge gained in the second year courses.

METE301 Phase Equilibria (3-0)3
Phase diagrams of materials systems. Geometric relationship and thermodynamic fundamentals. Phase relations in uniary systems, binary isomorphous systems, and binary systems containing invariant reactions. Ternary systems; projections of liquidus and solidus surfaces, Alkemade lines, compatibility relations, ternary invariant reactions, paths of equilibrium crystallization, isothermal and vertical sections.

METE302 Principles of Solidification (3-0)3
Liquids and Solids. Solidification of pure metals. Homogeneous and heterogeneous nucleation. Solidification of alloys, undercooling, solidification of eutectics. Constitutional undercooling. Growth in pure metal and alloys. Distribution coefficient. Macrostructure development. Classification of alloys according to their freezing range. Centerline feeding resistance. The rate of solidification, heat transfer in solidification. Segregation, single crystal growth, zone refining, rapid solidification.

METE303 Mechanical Behavior of Materials (4-0)4
Continuum mechanics; concepts of elasticity and plasticity. Micromechanics of deformation in metals, ceramics, and polymers. Dislocation slip, twinning and plasticity of polymers. Strengthening mechanisms. Time and temperature dependent deformation; creep, superplasticity, and viscoelasticity. Fracture behavior of materials; ductile and brittle fracture mechanisms, fracture transitions. Principles of fracture mechanics and toughness. Fatigue of materials; fatigue design and life prediction.

Undergraduate Curriculum

Fourth Semester		
ES 223	Statics and Strength of Materials	(4-0)4
METE 202	Materials Science II	(3-0)3
METE 204	Thermodynamics of Materials I	(3-0)3
METE 206	Materials Laboratory	(1-2)2
ES 361	Computing Methods in Engineering	(3-0)3
Any 1 of the following set...		
PHSY 207	Concepts of Modern Physics	(3-0)3
CHEM 202	Fundamentals of Organic Chemistry	(3-0)3
BIO 255	Molecular Cell Biology	(3-0)3
Any 1 of the following set...		
HIST 2202	Principles of Kemal Ataturk II	NC
HIST 2206	History of the Turkish Revolution II	NC
Fifth Semester		
METE300	Summer Practice I	NC
METE301	Phase Equilibra	(3-0)3
METE303	Mechanical Behavior of Materials	(4-0)4
METE305	Transport Phenomena	(4-0)4
METE307	Metallic Materials & Metallography	(3-2)4
METE349	Electrical, Magnetic & Optical Properties of Materials	(3-0)3
Any 1 of the following set...		
TURK 105	Turkish I	NC
TURK 201	Elementary Turkish	NC
TURK 303	Turkish I	NC

Course Descriptions

METE305 Transport Phenomena (4-0)4
Basic concepts in transport phenomena. Mass, energy and momentum balances. Classification of fluid flows and friction; laminar and turbulent flow. Mass transport; diffusion in the solid state, multicomponent diffusion and diffusion in multiphase alloys. Heat transport; conduction, convection and radiation.

METE306 Chemical Principles of Primary Materials Processing (4-0)4
Unit operations and unit processes in metallurgy. Overview of pyro, hydro, and electrometallurgical principles. Thermodynamics and kinetics of chemical reactions. Effects of concentration and temperature on rates of chemical reactions. Pretreatment, reduction, smelting and matte smelting processes with selected examples on the metallurgy of copper, iron, zinc and lead. Stoichiometric principles, charge calculations, and material balance. Heat balance; choice of reactions, with selected examples on non-ferrous metals and ferrous alloys.

METE307 Metallic Materials & Metallography (3-2)4
Fundamentals of microstructural characterization of metals. Specimen preparation. Optical microscopy examination. The correlation of the microstructure with the processing history and the properties of the metal alloys. Ferrous alloys. Non-ferrous alloys. Lightweight alloys and high-temperature alloys. The microstructure - property relationship in advanced alloys developed for automotive industry, chemical industry, power plants, nuclear plants and medical applications. Scanning electron microscopy examination. Fractography. Failure of alloys. Failure analysis and microstructure.

METE308 Physical Foundation of Materials (4-0)4
Homogeneous and heterogeneous nucleation. Interfaces: classification, geometry and energy of interfaces, grain boundary segregation, mobility of interfaces and normal grain growth. Precipitation: free energy-composition diagrams, precipitation transformations and kinetics, coarsening. Eutectoid transformation and discontinuous precipitation. Recovery and recrystallization.

METE310 Structure and Characterization of Materials (3-2)4
Concepts of short and long-range order; symmetry operations, symmetry elements, group theory, point groups, space groups, reciprocal lattice, tensor representation of crystals and their properties, nature and properties of X-ray and electron beams, X-ray and e-beam spectroscopy, X-ray and electron diffraction, phase identification, structure determination, crystallite and microstrain measurement, precise lattice parameter measurement.

Undergraduate Curriculum

Sixth Semester

METE 302	Principles of Solidification	(3-0)3
METE 306	Chemical Principles of Primary Materials Processing	(4-0)4
METE 308	Physical Foundations of Materials	(4-0)4
METE 310	Structure and Characterization of Materials	(3-2)4
METE 350	Multi-Scale Modeling & Simulation of Materials	(2-2)3
Any 1 of the following set...		
TURK 106	Turkish II	NC
TURK 202	Intermediate Turkish	NC
TURK 304	Turkish II	NC

Seventh Semester

METE 400	Summer Practice II	NC
METE 401	Materials Engineering Design I	(3-0)3
METE 451	Ceramic Materials	(3-0)3
METE 453	Polymer Materials	(3-0)3
	Technical Elective	(0-0)3
	Technical Elective	(0-0)3
	Non-Technical Elective	(0-0)3

Eighth Semester

METE 402	Materials Engineering Design II	(1-4)3
	Technical Elective	(0-0)3
	Technical Elective	(0-0)3
	Non-Technical Elective	(0-0)3
	Non-Technical Elective	(0-0)3
	Free Elective	(0-0)3

Course Descriptions

METE349 Electrical, Magnetic and Optical Properties of Materials (3-0)3
Electron energy levels and bands. Free electron theory of metals. Fermi-Dirac statistics. Metals, semiconductors, insulators. Electronic transport, conduction in metals. Electrical resistivity of metals. Intrinsic and extrinsic semiconductors. Superconductors. Electrical properties of junctions. Techniques of making p-n junctions. Magnetic properties of materials: diamagnetic, paramagnetic materials, ferrites. Optical properties of materials.

METE350 Multi-Scale Modeling and Simulation of Materials (2-2)3
Basics of computational materials science. Mathematical and physical basis of modeling. Methodology for developing models. Simulation of models as finite systems. Microscale methods: molecular dynamics and Monte Carlo. Mesoscale methods: kinetic Monte Carlo, Monte Carlo at the mesoscale, cellular automata, phase-field, dislocation dynamics and crystal plasticity. Macroscale finite element methods and integrated modeling and simulation at multiple-scales.

METE388 Materials Research I (0-2)1
A research activity of one term duration on selected topics in material science and engineering. The course aims to develop skills of performing basic experiments, reviewing the relevant literature and report writing.

METE400 Summer Practice II (Non-Credit)
Summer practice of at least 21 working days carried out in an establishment suitable with option courses followed in the third year. A comprehensive report is required which will combine the knowledge gained in the third year courses with the practical experience gained by the student.

METE401 Materials Engineering Design I (3-0)3
Design process. Steps of design. Design tools. Designing again failure. Materials selection design. Process selection in design. Case studies in materials and process selection. Economic decision making in design. Engineering ethics and discussions.

METE402 Materials Engineering Design II (1-4)3
Capstone design project course. Design of devices, parts, processes or systems related to metallurgical and materials engineering. Ethics in engineering and design, professional safety issues and discussions.

METE407 Chemical Metallurgy II (3-0)3
Generalised treatment of thermodynamic and kinetic principles of refining processes. Refining of lead, fire refining of copper, steelmaking. Gases and inclusions in metals, degassing, deoxidation, desulfurization, stirring and injection processes. Special refining processes. Thermodynamic and kinetic principles of electrochemical systems and processes. Reversible electrode potentials, polarization, recovery of metals from aqueous and fused salt solutions. Electrorefining, electroplating, electropolishing processes, anodizing andintegral coloring. Melting, remelting and melt preparation.

Course Descriptions

METE411 Chemical Metallurgy of Steel (3-0)3
Introduction to iron and steelmaking processes. Blast furnace and its description. Reduction of iron oxides, bosh and hearth reactions, slag formation. Blast furnace operating practice, treatment of hot metal. Steelmaking; description of steelmaking processes, oxidation reactions, S, P, N, H in steelmaking. Alloy steelmaking. Deoxidation. Ladle metallurgy.

METE414 Steels and Steel Production Technologies (3-0)3
Importance of steel: modern technological developments in the steel industry; clean steel production techniques; ladle metallurgy; continuous casting technology,. Classification of steels: structural steels; HSLA steels; dualphase steels; tool steels; high manganese austenitic steels; stainless steels. Steel selection process: selection according to properties. Hardenability and selection according to hardenability.

METE416 Fuels and Furnaces (3-0)3
Classification of solid, liquid and gaseous fuels. Carbonization and coke making. Combustion of fuels and heat utilization. Classification of furnaces; ladle and laboratory furnaces. Classification, properties and testing of refractories. Interaction of refractories with gas, metal, and slag phases. Selection of refractories; blast furnace, steel plant, reverberatory furnace, converter, electric arc and plasma furnace refractories. Manufacture of refractories.

METE417 Computer Applications in Metallurgy (2-2)3
A sampling of extraction metallurgical problems that are solved by computers. Scientific and research applications; analysis of metallurgical data, process simulation and control. The examination of selected examples of computer usage will suggest how other complicated time consuming problems can be solved.

METE418 Unit Operations and Pretreatment Processes (3-0)3
Drying; principles of drying equipment. Calcination; principles of calcination, calcination furnaces. Roasting; thermochemistry, types of roasting, roasting furnaces and product control. Agglomeration processes; sintering, pelletizing, nodulizing, and briquetting. Theory of sintering and pelletizing. Description of industrial agglomeration processes. Solid state reduction processes; direct and indirect reduction.

METE421 Glass Science and Technology (3-0)3
Structure of glass. Glass formation. Nucleation and crystallization in glasses. Oxide and chalcogenide glasses. Glasses for various applications. Viscosity of glasses. Glass melting. Principles of glass working. Forming processes in glass technology. Stresses and stress relaxation in glass; annealing and tempering. Corrosion and weathering of glasses strengthening of glasses. Optical and elastic properties of glasses. Glass defects.

METE422 Structural Ceramics and Ceramic Composites (3-0)3
Importance of structural ceramic materials. Constituent materials; oxides, non-oxides, fibers, whiskers. Forming of structural ceramics; slurry, plastic forming and pressing techniques. Composite fabrication and processing. Transformation toughened ceramics. Glass-ceramics. Non-oxide ceramics; carbides, nitrides, brides, etc.

METE433 Materials for Organic Electronics (3-0)3
Fundamentals of organic semiconductors and their applications in electronic and photonic devices; materials, manufacturing issues and applications in organic field effect transistors (OTFTs); light emitting diodes (OLEDs); photovoltaic devices (OPVs); memory devices; smart windows.

METE434 Principles of Ceramic Processing (3-0)3
Characterization of ceramic powders; size, surface area, density and porosimetry. Particle size and distribution, particle statistics. Particle packing. Methods of ceramic powder synthesis. Surface chemistry and rheology. Powder forming techniques; additives, pressing, slip casting, extrusion, injection molding. Densification of powder compacts; theory and practice of sintering processes, solid state sintering, liquid phase sintering, pressure sintering.

METE435 Foundry Laboratory I (2-2)3
Thermal analysis, heating and cooling curves of alloys and pure metals, principles of temperature measurements, macroexamination of cast-ingot structures, growth of solid grains in pure metals and alloys. Production of nodular cast iron, magnesium addition and innoculation. Chill testing of cast iron.

METE436 Foundry Laboratory II (2-2)3
Molding sands and sand casting, refractoriness test, mold making practice, carbon dioxide molding, core and mold making with organic binders, heat curing binders, core oils, core resins, methylene blue test.

METE440 Total Quality Management in Metallurgical Industries (3-0)3
Introduction to quality, quality assurance, fundamentals of statistics, control charts for variables, fundamentals of probability, control charts for attributes, reliability, quality costs, product liability.

METE441 Melting and Casting (3-0)3
Foundry sands, green sand concept, quartz-clay interface, clay-clay interface, Quartz-clay-water interface. Moulding mixtures, additives core concept; oil bonded cores. CO2 process, cold setting, core making. Casting processes; sand casting, die casting, centrifugal casting, investment casting, other processes. Melting methods, melting furnaces. Melting of cast iron in cupola. Non-ferrous industrial alloys; Al-alloy Cu-alloy, other nonferrous alloys. Steel casting processes.

METE442 Energy Storage Devices (3-0)3
Fundamentals of electrochemistry, electrochemical thermodynamics and transport. Energy storage and conversion devices such as primary and secondary batteries, fuel cells and solar cells. Principles of their operation, design concepts and materials considerations. Advances in secondary lithium batteries, cathode and anode materials, and hydrogen storage materials.

METE443 Multi-Physics Modeling in Materials Science and Engineering (2-2)3
Phenomenological computational modeling and simulation techniques in materials science and engineering. Mathematical and physical basis of modeling, methodology: definition of the physical problem, defining input and outputs, construction of the model, computer implementation, validation and visualization. Application of the methodology for materials behavior and processing problems like creep, fatigue, phase transformations, sintering, electrochemical reactions, welding, plastic deformation, solidification, etc. Simulation methods of materials science related phenomena like diffraction, thermodynamics and kinetics of reactions, mass and heat transfer, etc.

METE444 Electronic and Magnetic Ceramics (3-0)3
Interaction of ceramic materials with electromagnetic waves. Review of charge transfer and charge displacement processes. Electrical and ionic conduction in crystals and glasses. Dielectric behavior, ferroelectricity; piezoelecricity, and magnetic properties of ceramics. Effects of processing parameters on microstructure and properties. Examples on the manufacture of ceramic resistors, conductors, thermistors, capacitors, piezoelectrics, and magnets.

METE451 Ceramic Materials (3-0)3
Classification of ceramic products with respect to their functions. Classical and modern Ceramics. Methods of ceramic production: Natural and synthetic raw materials, shaping methods, drying and firing of ceramic articles. Effect of processing on the development of microstructures and properties. Examples of ceramics selected from the major groups of triaxial whitewares, electrical ceramics, magnetic ceramics, refractories, cements and mortars, abrasives, glasses and glass ceramics.

Course Descriptions

METE453 Polymer Materials (3-0)3
Relationships between structure, properties and processing of polymer materials. Effects of compounding, reinforcing and processing on the behavior of three basic classes of polymers; thermoplastics, thermosets and elastomers. Polymer blends and composites. Materials selection during design of polymer **c**omponents for strength, stiffness, toughness, resistance to fatigue, creep, and hostile environments. Comprehensive comparison of the behavior of polymer materials with metals and ceramics.

METE456 Surface Processing of Materials (3-0)3
Introduction to services and interfaces, structure and properties of interfaces. Different coating methods. Surface processing techniques that involve chemical and physical changes; special surface treatmenttechniques. Surface processing selection and controlling surface quality.

METE462 Residual Stress in Materials Processing (3-0)3
Residual stresses. Their origin depending on the industrial processes. Measurement and evaluation. Effect of residual stresses on design, service performance and failure of components.

METE464 Heat Treatment of Metals (2-2)3
Property changes due to heat treatment. Iron-carbon system. Austenitizing transformation of austenite, I-T and C-T diagrams, annealing, normalizing, hardening, critical cooling rate. Actual cooling rate, quenching media, size and mass effect. Hardenability and applications of hardenability data. Tempering. Secondary hardening, temper embrittlement, austempering. Case hardening. Residual stresses, martempering.

METE466 Powder Metallurgy (3-0)3
Principles of the P/M process. Powder characterization, properties of metal powders and their testing. Methods of metal powder production. Precompaction powder handling. Compaction processes. Densification mechanisms. Sintering theory. Liquid phase and activated sintering. Sintering atmospheres and furnaces. Full density processing. Finishing operations. Compact characterization.

METE468 Welding Metallurgy (2-2)3
Joints and welds, manual arc welding, electrodes and techniques. Gas welding and cutting, plasma arc and other cutting processes. Arc welding metallurgy. Testing and inspection. Welding of alloy and carbon steels. Welding of cast iron. Welding of non ferrous metals. Equipment and technique for TIG welding. Weld defects. Weld distortions.

METE470 Composite Materials (3-0)3
Principles of composites and composite reinforcement. Fiber reinforced composites. Laminated composites. Role of fiber, matrix and fiber-matrix interface in composite behavior. Continuous and discontinuous fiberstrengthening. Calculation of thermoelastic properties and strength. Tensile and compressive behavior. Fracture behavior and toughness. Corrosion and degradation of composites. Mechanical testing. Applications of composite materials.

METE472 Corrosion and Oxidation of Metals (3-0)3
Electrochemical principles of corrosion; review of thermodynamic approach as related to corrosion tendency, polarization and its application to corrosion rates. Passivity. Types of corrosion damage. Corrosion in various environments. Principles of corrosion control: design; material selection, surface coatings, treatment of environment, anodic and cathodic protection. Oxidation and tarnish of metals.

METE474 Failure Analysis (3-0)3
Objectives of failure analysis. General procedure of a failure investigation: Collection of background data, preliminary examination, nondestructive testing, destructive testing. Macro and micro inspection of fracture surfaces: Metallographic and fragtopraphic analyses, chemical analyses. Determination of fracture type. Application of fracture mechanics. Case studies that demonstrate various types of component failures and the preventive measures.

METE477 Testing and Evaluation of Engineering Materials (2-2)3
Introduction to testing of engineering materials, data collection and evaluation. Load and strain measurements. Calibration of equipment. Hardness measurement. Testing under static tension, compression, torsion and bending. Fatigue, impact and fracture toughness testing. Testing for high and low temperature behavior. Stress corrosion cracking testing. Fractographic analyses. Examples of testing for conformance to product specification.

METE478 Nondestructive Evaluation of Materials (2-2)3
General description of most common NDT methods. NDT detection of metallurgical properties of metals their composition and size differences, Application of nondestructive evaluation for metallurgical processes and products. NDT detection in service produced defects mainly caused by thermal shock, fatigue, creep, or by corrosion attack.

METE480 Electron Microscopy in Materials Science (2-2)3
History of electron microscope, optical column and dedection systems, concepts of signal and noise, resolution, depth of field, elastic and inelastic scattering, X-ray production, secondary electrons, back-scattered electrons, Auger electrons, contrast mechanisms, electron back-scattered diffraction, X-ray spectroscopy, miscellaneous scanning electron microscopy tehniques, pseudo-coloring and image analyses.

METE481 Special Topics in Metallurgical Engineering (3-0)3
This code number will be used for technical elective course which is not listed regularly in the catalog. The course content will be announced before the semester commences.

METE482 Special Topics in Materials Science and Engineering (3-0)3
This code number will be used for technical elective course which is not listed regularly in the catalog. The course content will be announced before the semester commences.

METE487 Thin Film Materials and Its Applications (3-0)3
Material science and physics of thin films and thin film devices; Epitaxial growth and deposition; Clean-room micro and nano device processing; Characterization and testing methods; Structural and other functional thin film coatings; Electronic, optical and magnetic thin film devices: transistors, detectors, solar-cells, LEDs, LDs.

METE488 Materials Research II (1-2)2
A research activity of one term duration on selected topics in material science and engineering. The course involves a systematic experimental program structured for a clearly defined objective and report writing.

METE489 Biomaterials (3-0)3
History of biomaterials, basic biological principles for engineers, light microscopy techniques, metallic, ceramic, polymeric and composite biomaterials, mechanical and surface characterization of biomaterials, corrosion, mechanical properties of implants, 3D printing of implants, quality control and regulatory issues in biomaterials, statistics for biomaterial scientists.

Minor Program

Minor Program in Structural Materials
Compulsory courses:

METE201 Materials Science I	(3-0) 3
METE202 Materials Science II	(3-0) 3
METE303 Mechanical Behavior of Materials	(4-0) 4

4 elective courses approved by the Department of Metallurgical and Materials Engineering.
Total minimum credit: 22

Minor Program in Ceramic Materials
Compulsory courses:

METE201 Materials Science I	(3-0) 3
METE202 Materials Science II	(3-0) 3
METE451 Ceramic Materials	(3-0) 3

4 elective courses approved by the Department of Metallurgical and Materials Engineering.
Total minimum credit: 21

Minor Program in Electronic Materials
Compulsory courses:

METE201 Materials Science I	(3-0) 3
METE202 Materials Science II	(3-0) 3
METE349 Electrical, Magnetic and Optical Properties of Materials	(3-0) 3

4 elective courses approved by the Department of Metallurgical and Materials Engineering.
Total minimum credit: 21

Graduate Curriculum

M.S. in Metallurgical and Materials Engineering

M.S. Program through courses and thesis aims to provide advanced level of knowledge in the field as well as tools and techniques of research with their implementation within the context of a comprehensive thesis.

METE500	M.S. Thesis	NC
METE508	Characterization of Materials	(2-2)3
METE570	Research Methods and Ethics in Metallurgical and Materials Engineering	(2-0)2
METE575	Foundations of Engineering Materials	(4-0)4
METE580	M.S. Seminar	NC

4 elective courses approved by the Department of Metallurgical and Materials Engineering.

Ph.D. in Metallurgical and Materials Engineering

The program through doctoral dissertation aided by courses aims to provide maturity in the knowledge as well as to advance it beyond the level already known. The ability to conduct independent research, the creativity in the tools and techniques of research, ability for formulating steps to reach new synthesis are the main objectives.

METE501	Thermodynamics in Materials Science and Engineering	(3-0)3
METE506	Kinetics in Materials Science and Engineering	(3-0)3
METE570	Research Methods and Ethics in Metallurgical and Materials Engineering	(2-0)2
METE581	Ph.D. Seminar	NC
METE600	Ph.D. Thesis	NC

5 elective courses approved by the Department of Metallurgical and Materials Engineering.

Course Descriptions

METE500 M.S. Thesis (Non-Credit)
Program of research leading to M.S. degree, arranged between student and a faculty member. Students register to this course in all semesters starting from the beginning of their first semester while the research program or write-up of thesis is in progress.

METE501 Thermodynamics in Materials Science and Engineering (3-0)3
Thermodynamic properties of inorganic materials. Laws of thermodynamics and their application to the chemical behavior of materials systems. Multicomponent systems, phase and chemical reaction equilibria. Thermodynamics of phase transformations. Thermodynamics of surfaces, interfaces and defects.

METE502 Diffusion (3-0)3
Phenomenological theory of diffusion. Thermodynamic principles. Fick's laws. Chemical diffusion, Kirkendall effect, Up-Hill Diffusion, etc. Atomic theory of diffusion. Atom movements, Random Walk Diffusion in non-metallic and fluid systems. Diffusion with moving boundary.

METE503 Math. Methods in Materials Research (3-0)3
Review of ordinary differential equations, partial differential equations, solution techniques, special functions, separation of variables, transform techniques, approximate techniques.

METE505 Fracture (3-0)3
Engineering aspects of fracture. Fracture mechanics design philosophy. Case studies in brittle fracture, ductile fracture, environmental cracking, fracture under fatigue and creep.

METE506 Kinetic of Processes in Materials Science and Engineering (3-0)3
Introduction to kinetic processes in materials. Reaction kinetics, reaction order and analysis of kinetic data. Transport in solids, liquids and gases. Diffusion in the solid state, atomistic and continuum approach, multicomponent and multiphase diffusion. Diffusion in ordered and ionic crystals. Diffusion in fluids; boundary later and mass transfer coefficient. Metal-slag reaction, fluid-particle reaction. Dimensionless numbers.

METE507 Advanced Crystallography and Diffraction (2-2)3
Advanced theory of diffraction. Matrix operations and their application to crystallography. Symmetry, space groups structure analysis, imperfect lattices, strain and texture. Diffraction in non-crystalline materials.

METE508 Characterization of Materials (2-2)3
Theory behind various material characterization techniques. Transmission electron microscopy (TEM), scanning electron microscopy (SEM), advanced X-ray diffraction (XRD) techniques, atomic force microscopy (AFM). Fourier-transform infrared spectroscopy (FTIR), ultraviolet/visible spectroscopy(UV/VIS), Raman spectroscopy. Differential thermal analysis (DTA), thermogravimetric analysis (TGA), differential scanning calorimetry (DSC). Dynamic light scattering (DLS), zeta potential analysis, Vibrating-sample magnetometer (VSM), Hall effect set-up.

Graduate Curriculum

Integrated Ph.D. in Metallurgical and Materials Engineering

METE501	Thermodynamics in Materials Science and Engineering	(3-0)3
METE506	Kinetics in Materials Science and Engineering	(3-0)3
METE508	Characterization of Materials	(2-2)3
METE570	Research Methods and Ethics in Metallurgical and Materials Engineering	(2-0)2
METE575	Foundations of Engineering Materials	(4-0)4
METE581	Ph.D. Seminar	NC
METE600	Ph.D. Thesis	NC

9 elective courses approved by the Department of Metallurgical and Materials Engineering.

METE509 Physics of Materials I (3-0)3
Theoretical basis of structure and properties of materials, quantum mechanical theory of bonding, quantum mechanical theory of metals and alloys (Free Electron Theory, Band Theory).

METE510 Physics of Materials II (3-0)3
Electrical properties of insulators and semiconductors, optical properties of insulators and semiconductors. Magnetism (Quantum Mechanical Theory, Ferromagnetism, Domains, Anisotropy, Magnetostriction), Magnetic resonance techniques.

METE515 Composite Materials (3-0)3
Principles of composites and composite reinforcement. Micro-mechanics and fracture behaviour of composites. Static and time dependent behaviour of Composites.

METE516 Production of Ferroalloys (3-0)3
Production of ferro-alloys by carbothermic reduction, with special emphasis on ferro silicon; Production of ferro alloys by metallothermic and vacuum reduction techniques; Detailed explanation of ferro- chromium, manganese titanium, vanadium, tungsten and molybdenum production; Halide metallurgy; Production of volatile metals especially zinc and magnesium .

METE521 Advanced Foundry Technology (3-0)3
Mathematical analysis of solidification. Heat transfer problem in ingot casting. Continuous casting process. Refined melting techniques. Metallurgy and casting of corrosion resistant and heat resistant alloys and special steels.

Course Descriptions

METE522 Bioceramics (3-0)3
Synthesis, processing and characterization of ceramics and ceramic-based systems for applications in biomedical use. Calcium phosphate chemistry, calcium phosphate cements, sol-gel chemistry, glass formation, glass-ceramics and bioglass. Bioinert ceramics, alumina, zirconia, carbon-based coatings. Selected applications of bioceramics in medical use.

METE523 Molten Salt Electrolysis (3-0)3
Physicochemical properties of melts; structure of melts. Thermodynamics of molten salt mixtures; activity models, melts with common ion, complex formation, reciprocal salt systems. Galvanic concentration cells, membrane potential. Electrolysis in molten salts, Faraday's law, metal solubility, current efficiency, electrode kinetics. Industrial applications; Hall-Heroult process, magnesium electrolysis.

METE525 Extractive Metallurgy of Copper (2-2)3
Comminution and concentration of copper ores; Roasting of copper concentrates; Physical chemistry of copper smelting; Matte smelting, converting of copper matter and copper losses in slags; Continuous production of blister copper: Single-step and multi-step processes; Hydrometallurgical extraction of copper; Electrolytic refining and electrowinning of copper.

METE534 Phase Transformations in Metallic Systems (3-0)3
Classification of solid state phase transformations; Solid solutions, intermetallic phases and order-disorder transformations; Precipitate nucleation, growth, coarsening and dissolution; Spinodal decomposition; Eutectoid transformations and coarsening of lamellar structures; Ferrous and non-ferrous martensite transformations: stabilization, thermoelasticity, reversibility, shape memory effect.

METE535 Transmission Electron Microscopy (2-2)3
Electron microscope: Specimen preparation. Reciprocal lattice concept and kinematical theory of electron diffraction. Diffraction pattern indexing and evaluation of spot patterns. Geometry of formation and applications of Kikuchi patterns. Constants and its applications in faulted crystals. Introduction to nonconventional techniques (lattice imaging, convergent beam, stereomicroscopy, 21/2D imaging).

METE538 Advanced Solidification (3-0)3
Atom transfer at the solid-liquid interface; conditions for nucleation, rate of nucleus formation, interface structure. Morphological instability of a solid-liquid interface, perturbation analysis. Solidification microstructures; cells and dendrites, eutectic and peritectic, diffusion coupled growth, competitive growth of dendritic and eutectic phases. Solute redistribution; mass balance in directional solidification, microsegregation. Rapid solidification processing; general characteristics, production methods, microstructural effects.

Course Descriptions

METE539 Near Net Shape Processing (3-0)3
The methods for manufacturing small section products such as strip, fibre, flake, wire directly from molten metal. Spray rolling, the Taylor wire process, melt spinning, melt overflow, melt drag, melt extraction, double roll quenching, thin slab casting (belt drive) and laser glaze process. Mass and heat flow analysis. Alloy design, dimensional control. Alloy parameters such as melt delivery speed, viscosity and surface tension.

METE540 Phase Stability in Alloys (2-2)3
Theoretical basis of structure of solid solutions; Quasi-chemical statistico-thermo dynamical and quantum mechanical theory of interatomic interactions in metals and alloys; theory of crystal-structure stability; Energy of phase boundaries; Ordered phases, their structure and existence conditions; Interatomic interaction in the fiber reinforced metal matrix composites.

METE544 Properties of Glasses (3-0)3
Composition-structure-property relations in glasses. Chemical properties, Physical properties, Thermal properties, Mechanical properties, Optical properties, Electrical properties; factors affecting these properties. Engineering the factors for specific glass applications. Testing of glassware.

METE545 Atomistic Computer Modelling of Materials (2-2)3
Theory and application of atomistic computer simulation methods to model, understand, and predict the properties of materials and simulate materials' behavior. Introduction to energy models, from empirical potentials to first-principles techniques. Deterministic, stochastic and static approaches for atomistic modeling; Molecular Dynamics (MD), Monte Carlo (MC) and energy minimization methods. Application of these methods to understand, phase transformations, stability, phase diagram determination, atomic transport, order-disorder, defects, interfaces and surfaces.

METE546 Nanostructured Materials (3-0)3
Introduction to nanometer scale materials; visions in nanoscience and engineering. Different techniques of synthesis for nanostructured materials; synthesis of nanoparticles, nanotubes/nanowires, nanoscale films and bulk nanoscale materials. Characterization of nanostructured materials by electron microscopy, X-ray diffraction and spectroscopical techniques. Properties of nanostructured materials.

METE550 Solar Cells (3-0)3
Fundamentals of solar cells. Properties of sunlight, interaction of light with matter. Introduction to semiconductors for solar cell applications, fabrication routes and working principles. Theory of conventional pn junction and excitonic solar cells. Material issues and effect of nanostructures in silicon based, thin film, tandem, dye-sensitized and organic solar cells, including emerging solar cell concepts such as perovskite solar cells

METE555 Processing and Properties of Nanocomposites (3-0)3
Basic concepts in composite materials science. Fundamentals of nanomaterials and nanocomposites. Ceramic matrix nanocomposites. Metal matrix nanocomposites. Polymer nanocomposites. Processing of nanocomposite materials. Effect of interface on the properties of nanocomposites. Nanocomposites for surface applications. Application-specific nanocomposites. Natural nanocomposites. Biometic and bioinspired nanocomposites.

METE560 Polymer Nanocomposites (3-0)3
Definition of polymer nanocomposites.Comparision with micro-and macro-scale polymer composites.Types of polymeric matrix materials and nano-particulates used.Importance of interface between matrix and nano-phase.Problems and difficulties in the production methods of polymer nanocomposites.Characterization and testing of polymer nanocomposites.Mechanical behavior,thermal response,flame retardancy,chemical resistance,and electrical-magnetic-optical properties of polymer nanocomposites. Applications and future trends of polymer nanocomposites.

METE565 Structure of Materials (3-0)3
Concepts of short and long-range order;symmetry operations ,symmetry elements,group theory,point groups,space groups,reciprocal lattice;nature and properties of powder diffraction,source of radiation (X-ray,neutron,and electron), powder diffraction data collection;crystal structure solution and refinement from powder diffraction data (Rietveld refinement);pair-distribution function,structure-property relationship (covalent, ionic, metallic solids,glasses,polymers).

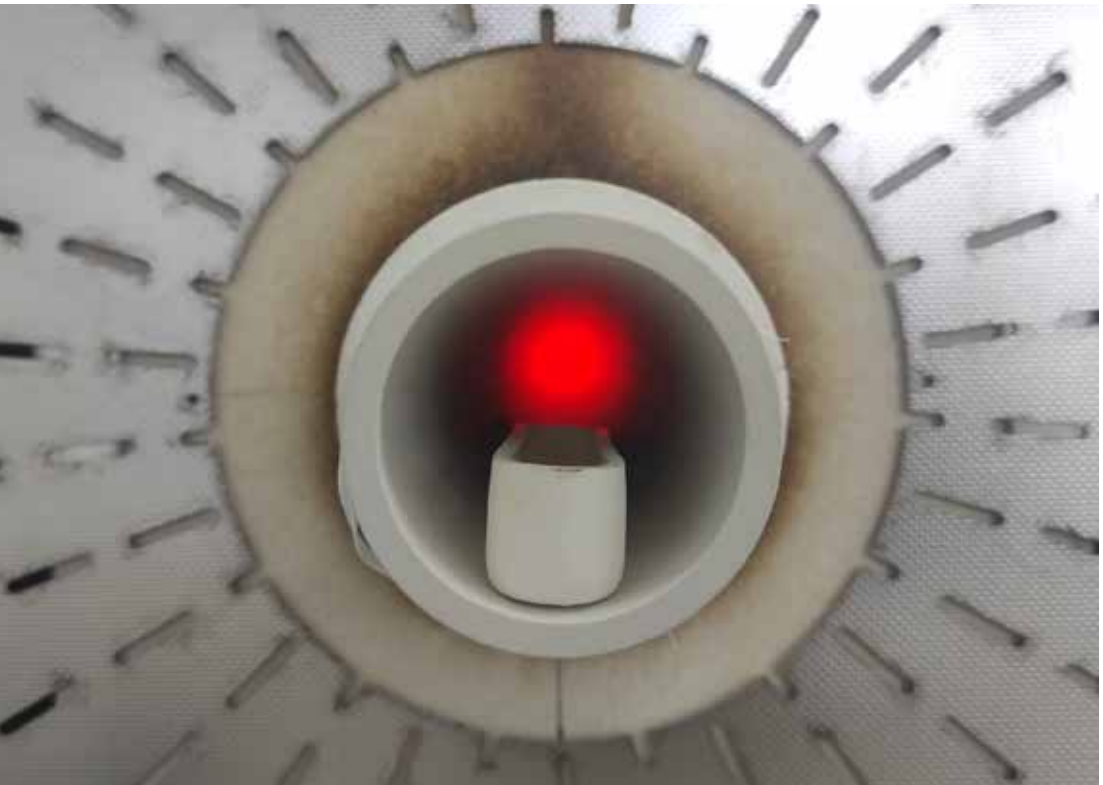
METE570 Research Methods and Ethics in Metallurgical and Materials Engineering (2-0)2
Introduction to the scientific research and ethical behaviour. Carrying out literature review and acquiring knowledge from scientific articles. Formulating research goals and making a plan to reach these goals. Writing an independent research proposal. Ethical behaviour in research process and in presentation of results. Quality in research and ability to reason in critical manner. Quality control and improving the knowledge in scientific literature in a specific research area.

METE575 Foundations of Engineering Materials (4-0)4
Advanced topics in material science and engineering. Physical, chemical and mechanical properties of metal, ceramics, polymers and composites.

METE587 Materials for Energy Storage and Conversion (3-0)3
Energy storage and conversion: an overview. Material characterization: advanced microscopical techniques, focus ion beam and its applications, in-situ experiments in ES&C, FTIR and Raman spectroscopy, NMR, XPS. Electrochemical characterization: electrochemical hydrogen storage, Li-ion batteries, supercapacitors, fuel cells. Materials overviews for: electrochemical hydrogen storage, Li-ion batteries, supercapacitors, PEM fuel cells, solid oxide fuel cells.

Research Interests

Our department embraces the strong research tradition of METU, where our research interests and thesis studies span from metallurgical investigations including iron-steel, nonferrous alloys, casting, metal forming, heat treatment, surface modification, welding and nondestructive testing, which are most desired for our nations' industrial needs; to more materials science based research mainly targeted towards future technological improvements including electronic and magnetic materials, ceramics, biomaterials, nanotechnology and energy storage materials.



Research Laboratories

Nanomaterials and Devices Laboratory

The group is focused on the synthesis and solution processing of semiconducting and metallic nanowires/carbon nanotubes and exploiting their novel properties in flexible and wearable devices. Devices of interest include, but not limited to solar cells, light emitting diodes, triboelectric nanogenerators, supercapacitors, sensors and photodetectors.

Major devices used in the laboratory:
Ultrasonic spray pyrolysis system, physical vapor deposition system, Mayer rod/dr blade coating setups, shear exfoliator, glove box, spectrometer/photometer/integrated sphere, light sources/UV lamps, sourcemeters/picoammeter, autoclaves, galvanostat/potentiostat systems, 3D printers, thermal camera, impedance/gain-phase analyzer, data acquisition/control unit, LCR meter, 4-probe conductivity meter, coin cell assembly setup.

Biomaterials and Nanomedicine Laboratory

The research group is interested in integrating fundamental materials science concepts with biological principles to improve currently-used biomaterials to heal damaged tissues. Particularly, biomaterial surfaces are modifed to possess nanofeatures to bone, vascular and cardiac cell interactions, while enhancing antibacterial properties.

Major devices used in the laboratory
Electrochemical anodization set-up, Lyophilizer, Inverted microscope, Incubator, Class II biological safety cabinet, freezer, microplate reader, liquid nitrogen tank.

Bioceramics and Materials Chemistry Laboratory

A processing laboratory specializing in low-temparature materials synthesis by chemical routes, suited for S olGel processing of ceramics and glasses and coatings; hybrid bio/inorganic and organic/inorganic materials; synthesis and processing bioceramics (calcium phosphates, bioglass etc.) by different means including additive manufacturing (3D-printing) and cement ro FTIR Spectrometer, UV-Vis Spectrometer, Isothermal Titration Calorimeter, Coating equipment (Laurell WS-400B-6NPP-LITE spin coater, Bungard RDC15 dip coater) General Laboratory equipment/appliances: A wet laboratory suitable for use of organic precursors, with water purification systems (DI-water), equipped with hot plates, mixers, drying ovens, furnaces, ambient and atmosphere controlled box and tube furnaces, ultrasonic baths and horn, homogenizators, pH meters, centrifuges.

Functional Nanomaterials Laboratory

The research is focused on the development of novel nanomaterials for various electronic/optoelectronic applications. The main research topics include, but not limited to, the colloidal synthesis of semiconductor nanocrystals, the surface chemistry and functionalization of nanocrystals and the optoelectronic applications of nanocrystals including light-emitting and lightharvesting devices.

Polymers and Nanocomposites Laboratory

The group is focused on the production and characterization of various polymer based nanocomposites using industrially compatible processing methods for engineering applications such as cable industry, electrical appliances industry, automotive industry.

Major devices used in the laboratory:
Twin-screw extruder for compounding, injection molding device, laboratory scale compression molding device, ball milling and screening system.

Coatings and Thin Films Laboratory

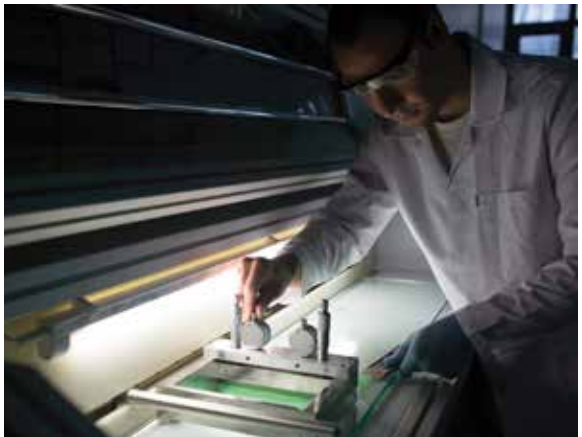
The research is mainly on high temperature and corrosion protection coatings, oxide thin films, and vacuum controlled heat treatment of metals and alloys.

Major devices used in the laboratory:
Chemical vapor deposition for aluminizing, chromizing and rare earth/transition metal modification in vertical furnace and a horizontal furnace, Atomic layer deposition system, low vacuum heat treatment furnace, metal coatings thickness measurement equipment, one dimensional profilometer.

Surface Science Research Laboratory

The group is focused on production and characterization of micron and nanoscale inorgan ic and metallic structures to be integrated into micro-electronical, optical and mechanical systems, solar cells and thermoelectric modules.

Major devices used in the laboratory:
Ferroelectric tester (Radiant), mercury probe, optical microscope, scanning thermometer, high current source, sensitive digital voltmeter, nanovoltmeter, temperature control unit, 4 point measurement system, microwave oven, sputter coating system, thermoelectric measurement system.



Colloid and Smart Materials Laboratory

The research is based on colloid and interfacial phenomena, and materials chemistry. The current research topics include, but not limited to, synthesis of micro and nanoparticles, colloidal processing, rheology, additive manufacturing of ceramics, functional and smart materials, and suspension flow batteries. The interdisciplinary research projects include metals, ceramics, polymers and their combinations in multicomponent systems.

Major devices used in the laboratory:
Rheometer, Particle size and zeta potential measurement system (Zetasizer), 3D-Printer for robo-casting of ceramics and printing of polymer-ceramic composites, high temperature furnace, high speed refrigerated centrifuge.

Electromagnetic Materials Laboratory

The group is focused on interaction of electromagnetic waves with matter, microwave processing of bulk and surface composites, electromagnetic interference shielding potential of multilayer composites as well as optical and mechanical characterization of ceramic composites, synthesis and characterization of textured barium ferrite ceramics and developing pathways for the processing of "bioinspired" polymer matrix composites.

Major devices used in the laboratory:
High temperature sintering furnace, microwave sintering furnace, cold isostatic press, tape caster, high shear mixer, titration system, vector network analyzer, free space measurement setup.

Photocatalytic Materials Laboratory

The group is focused on the synthesis and production of photocatalytic materials and evaluation of their photocatalytic properties. The studies of interest include self-cleaning applications, dye sensitized solar cells (DSSC), antibacterial coatings, dental materials.

Major devices used in the laboratory:
Planetary ball mill, centrifuge, spectrophotometer, autoclave, Pin-on disk type tribometer, light sources/UV lamps.

Thermochemical and Electrochemical Materials Processing Laboratory

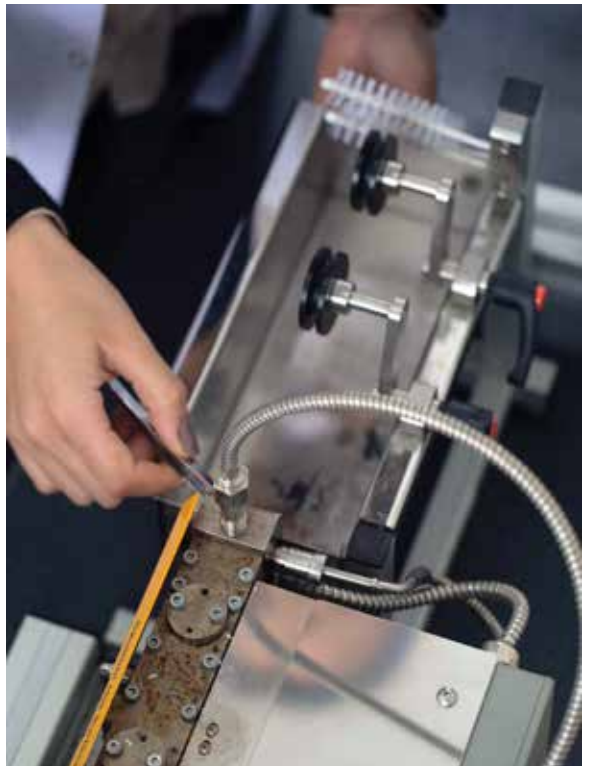
The group is focused on materials production, processing and properties that involve thermochemical and electrochemical applications. The theoretical and the experimental work on diffe ent kinds of energy exchanges accompanying production and processing reactions of materials are covered in thermochemical studies. Molten salt electrolysis, electro-deoxidation and electro-winning processes for metal production and electroforming, electroplating, electro-machining and electro-polishing in aqueous solutions are covered in electrochemical studies.

Major devices used in the laboratory:
Potentiostat/galvanostat system, X-ray fluorescence (XRF), power supplies, gas mixing and analyzing equipment, digital microscope, profilometer, deposit stress analyzer.

Novel Alloys Design and Development Laboratory

The group is focused on design, development and analysis of multicomponent intermetallic and metallic glass alloy systems which include nano-alloys, bulk amorphous and bulk nano-crystalline alloy systems. These studies are mostly supplemented with modeling and simulations to reveal atomistic mechanisms governing structure-property-performance relationships for alloys in consideration. The computational tools involve several workstations with first-principle calculation software such as abinit and Medea-Vasp, Molecular Dynamics and Monte Carlo packages and in-house electronic calculation, simulation and data analyses algorithms. Our group has a solid background in theoretical investigations of order-disorder and related phenomena in binary and ternary alloy systems. With our computational capabilities, we intend to compare/contrast such phenomena under finite surface conditions of nano-alloy forms also.

Major devices used in the laboratory:
Arc-melting and suction casting equipment, centrifugal casting equipment, differential scanning calorimeter (DSC), vibrating sample calorimeter (VSM), ball mill, muffle and elevator furnaces.



Materials for Extreme Applications Laboratory

The group is focused on the development, additive manufacturing and testing of the novel multicomponent materials, Nickel and Ferrous base nano-structured alloys for extreme applications, such as high temperatures (>1000°C), radiation and corrosion environments. Activities include materials design using thermo-chemical models and their additive manufacturing using fusion-based and cold spraying techniques. In order to simulate the extreme environments, high temperature in-situ and ex-situ irradiations are employed using high energy ion accelerators.

Major devices used in the laboratory:
Cold spray 3D metal printing system, atmosphere controlled planetary ball mill, atmosphere controlled and ambient atmosphere high temperature furnaces, twinjet automatic electrolytic sample polishing system, stereo microscope.

Energy Storage Devices and Battery Laboratory

The group is focused on the design, production and characterization of secondary batter ies based on Lead-Acid Ni–MH batteries and Li–ion batteries.

Major devices used in the laboratory:
Planetary ball mill, glove box, chamber and split and bottom loading furnaces, vacuum drying oven, humidity chamber, freeze dryer, potentiostat/galvanostat systems.

Energy Storage Materials Laboratory

The group deals with energy storage materials and the related areas. The main activity of the group is directed towards metal-hydrides of low stability, i.e. compounds capable of storing and releasing hydrogen near ambient condition, suitable for gas-solid and electrochemical storage of hydrogen. The group therefore deals with the synthesis of nanostructured materials using a variety of techniques i.e. mechanical milling, thin film processing and thermal plasma. Activities in the related fields cover hydrogen separation membranes and nano-porous materials.

Major devices used in the laboratory:
Vacuum/pressure induction melting system, glove box, magnetron sputtering system, induction plasma system with nano-powder reactor, spark discharge generator, Sievert's PCT instrument, gas permeability tester, potentiostat/galvanostat system.

Laboratory for Electrochemical Energy Materials

The group focusses on designing economically viable and active materials for devices based on low temperature electrolysis processes, e.g. metal-air batteries, hydrogen production and reversible solid oxide fuel cells. We combine fundamentals of materials science with electrochemistry to understand the materials degradation during electrochemical reaction and thus draw a holistic design strategy for high performance devices.

Major devices used in the laboratory:
Potentiostat/galvanostat systems, glove box, temperature controlled furnace, vacuum drying oven, rotating disc electrode system.

Metals Development Laboratory

The group is primarily focused on understanding the dynamical evolution and structural hierarchy at different length scales and controlling the phase selection mechanisms under far from equilibrium conditions in metallic systems. Area of interest include, but not limited to, amorphous and nanocrystalline metallic alloys, lead-free solders, high-entropy alloys, electronic packaging RE-free magnets, super-austenitic stainless steel and single crystal growth.

Major devices used in the laboratory:
Arc melting system with mini vacuum MAM-1 equipped with injection casting attachments (Edmund Bühler GmbH), allowing the synthesis and rapid solidification of alloys. Atmosphere-Vacuum Controlled Induction Furnace. Atmosphere-Vacuum Controlled Induction Furnace with vibration. SPEX 8000M high-energy mechanical milling. Atmosphere-Vacuum Controlled Quartz/Pyrex sealing systems (home-made) Several Types of box and tube furnaces, thermal-shock Instrument,

Foundry, Metal Processing and Automotive Materials Laboratory

This laboratory is equipped with casting, forging, rolling, thermal analysis system during solidification and semi industrial scale heat treatment furnaces. Equipment is available to study processing of both industrial alloys and metal matrix composites for automotive, defense and machine industry.

Major devices used in the laboratory:
Induction furnaces with different capacities, vacuum induction melting, pressure die caster, thixocaster, centrifugal casting machine, vertical hydraulic double action press multiple purpose for squeeze casting hot forming and powder pressing, aluminum melting resistance furnace, sand muller, optical emission spectrometer.

Solid Mechanics and Metal Forming Laboratory

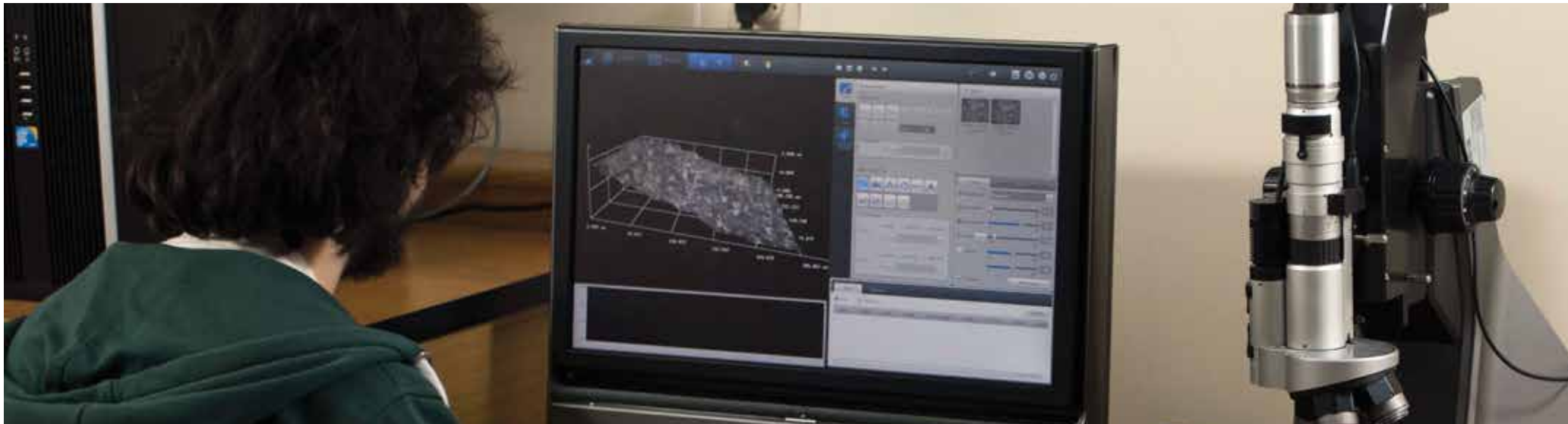
The group is focused on the observation of the in-situ formation and evolution of the surface defects during metal sheet forming by means of a novel test mechanism involving high resolution photography and digital image correlation (DIC) techniques. As an alternative to conventional macro-scale tests, we investigate the mechanical behavior of materials at microstructure scale (grain-scale). Interactions between microstructure evolution and defect formation will be analyzed, which results in solutions for will defect minimization and elimination during metal forming.

Major devices used in the laboratory:
Bending test machine, lens setup, rework station, CCD camera, light sources, cupping machine.

Integrated Computational Materials Science Laboratory

It is dedicated to establishing a strong integration between materials science and manufacturing engineering branches such as design, process and performance engineering. The laboratory is involved in computer modeling and simulations, with special focus on multi-scale and multi-physics simulations which are considered as the key elements of the integration.

Major devices used in the laboratory:
Workstations, softwares for material and process modeling.



Failure Analysis Laboratory

Failed parts from various application areas of the industry are analyzed to determine the type of fracture and the root cause of failure. Fatigue fractures, corrosion failures, SCC, HE, overloading fractures, defected materials, high-T failures, improper design, improper heat treatment and improper installation conditions are investigated.

Major devices used in the laboratory:
Scanning Electron Microscope, Stereo Optical Microscopes, Camera and macro-lens system. This laboratory uses the facilities of metallography, mechanical testing, XRD and NDT laboratories and the machine shop. There is an exhibition area for the typical examples of failed components.

Railway Equipment Testing and Research Laboratory

Rails of railway and metro lines, locomotive and wagon wheels, rail-sleeper connection components, sleepers, sleeper screws and rail pads are tested statically and dynamically. Fatigue, compression, tension, bending tests of railway components can be performed according to universal standards.

Major devices used in the laboratory:
600kN universal dynamic testing machine, 600kN static universal testing system, 300Ton servo-controlled compression testing machine for rail fracture test, drop-weigh impact tester for rails and sleepers, cooling chamber for sub-zero tests, strain measurement system, digital extensometers.

Educational Service Laboratories

Foundry and Alloy Preparation Laboratory

It is a facility dedicated to melting and alloying as well as casting of various alloys.

Major devices used in the laboratory:
Inductotherm magnethermic motor generator coreless induction furnace has a melting capacity of 10 kg aluminum alloy and 16-17 kg cast iron can be used to melt both ferrous and nonferrous alloys, Inductotherm minimelt induction furnace has a capacity of melting 25 kg ferrous alloy, Inde-mak coreless induction furnace has a melting capacity of 150 kg steel and cast iron, PLC controlled automatic hydraulic vertical squeeze casting press having 100 Tons locking and 70 Tons injection pressure for aluminum and metal matrix composite part production, 200 ton capacity pressure die casting machine, 15 ton capacity thixocaster, resistance heating furnace for melting and holding of aluminum alloys having capacity of 300 kg is available for aluminum pressure die and squeeze casting, drop bottom hydraulic atmosphere controlled industrial scale computer controlled programmable heat treatment and brazing furnace, drop bottom hydraulic industrial scale computer controlled programmable tempering heat treatment furnace, fuel fired furnaces, centrifugal casting machine, sand casting flasks, electroslag remelting unit, DC driver controlled 300 mm dia rolling, spray rolling and twin roll casting machine, foundry master optical emission spectrometer device working with CCD technology.

Ceramic Engineering Laboratories

They are dedicated to powder communition, ceramic powder processing through chemical routes, rheological characterization for the study of ceramic slurries and colloidal behavior, glass melting and crystallization, structural studies and thermal, mechanical, electrical and magnetic characterization of ceramics.

Major devices used in the laboratory:
Ceramic ball mills, slip casting, pressing, CIP and extrusion units, vacuum and pressure sintering furnaces up to temperatures of 2500 °C, glass melting and crystallization facilities, equipment for structural studies and for the characterization of thermal, mechanical, electrical, and magnetic properties of ceramics.

Powder Metallurgy Laboratory

It is dedicated for powder processing and compaction.

Major devices used in the laboratory:
Sieve shaker unit and standard set of sieves, a sintering furnace that can reach up to 1350 °C and a manual hydraulic press for the formation of powder compacts.

Heat Treatment Laboratory

It is a facility dedicated to heat treatment of various types of materials.

Major devices used in the laboratory:
Various muffle and tube furnaces that can operate under controlled atmospheres. Salt baths are available for different heat treatment applications.

Welding Technology Laboratory

It is dedicated for various welding operations such as gas welding, manual metal arc welding, MIG/MAG, TIG, spot welding, and hybrid plasma arc welding.

Major devices used in the laboratory:
Conventional welding process equipment for gas welding, manual metal arc welding, MIG/MAG, TIG and spot welding, hot cracking test (MVT-test), cold cracking test (implant test), hybrid plasma arc welding, and 3-axis CNC milling machine for sample preparation.

Undergraduate Processing and Research Laboratory

It is dedicated to undergraduate laboratory and research classes, as well as senior design projects. Wet chemical processing, thermo-mechanical processing, polymer processing and ceramic/powder processing is possible in these laboratories.

Major devices used in the laboratory:
Drying ovens and furnaces, hot plates, pH meters, ultrasonic cleaners, precision balance, hydraulic press, spin coater, twin-screw extruder, sintering furnace.

Mechanical Testing Laboratory

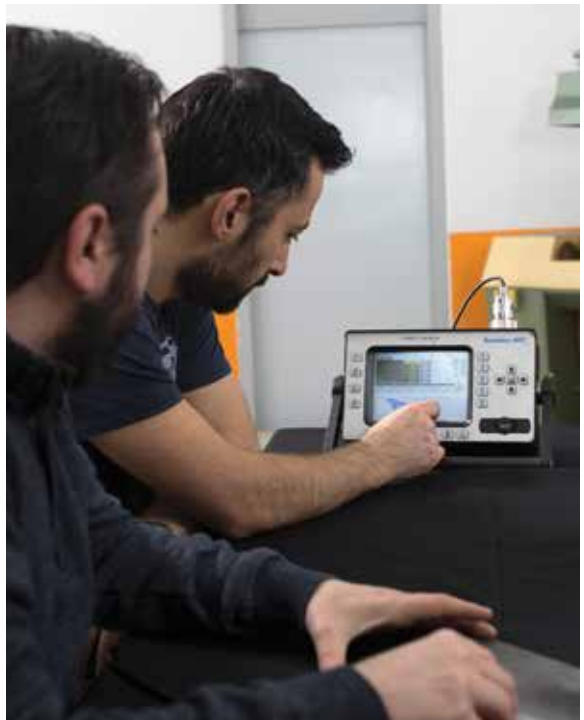
It is dedicated to the mechanical characterization of different materials including thin sheets, composites, polymers and ceramics.

Major devices used in the laboratory:
A INSTRON 5582 Universal Testing Machine, 10 ton capacity with high temperature furnace attachment and optical strain analysis, a INSTRON 5565A Universal Testing Machine with 0.5 ton capacity and miniature scale testing ability and optical strain analysis, various load cells and load indicators, a 10 ton MTS Universal Testing System for testing under controlled load, deflection or strain for fatigue, creep and stress relaxation studies, a 60 ton capacity AL[gA hydraulic tension compression bending testing machine, a 25 ton Dartec Universal Dynamic Testing Machine for tension, compression, bending and fatigue tests, a crack monitoring system for fracture toughness and fatigue crack kinetics tests, a TINIUS-OLSEN pendulum type Charpy impact tester, a desktoppendulum impact tester for ceramic, composite and polymeric materials, furnaces and cooling systems for impact testing at high and low temperatures, EMCO universal hardness tester for Brinell, Vickers and Rockwell measurements. a student type creep testing device and rotating beam fatigue testing machines.

Nondestructive Testing Laboratory

It is dedicated for nondestructive testing and evaluation of materials using various methods.

Major devices used in the laboratory:
Facilities for surface testing (visual, liquid penetrant, magnetic particle, and eddy current methods), film radiography with X-rays units (150 kV, 220 kV and 300 kV), digital radiography system (XYLON 2000D, 225 kV), analog and digital ultrasonic testing equipment, and phased-array equipment.



Electron Microscopy Laboratories

The department has SEM and TEM facilities for materials characterization. Facilities for sample preparation complement electron microscopy laboratories.

Major devices used in the laboratory:
A field emission SEM. FEI Nova Nano SEM 430 with a variety of detectors; Helix, vCD, STEM. This microscope is equipped with EDS analysis system and EBSD camera integrated to a common platform (PEGASUS) allowing local elemental analysis as well as phase and texture analysis, a 40 kV Jeol 6400 SEM equipped with digital imaging and Noran Inst. Series II X-ray microanalyser, a field emission TEM: JEOL JEM-2100F UHR/HRP 200 kV Microscope with 0.19 nm resolution equipped with STEM, EDS spectrophotometer and high resolution CCD camera, a 100 kV JEOLTEM100 CX transmission electron microscope. Sample preparation facility includes disc cutter, dimpling grinder, automatic twin jet polisher, ion mill, plasma cleaner, gold sputter coater.

Metallography and Image Analysis Laboratory

It is dedicated to metallographic sample preparation, optical microscopy, hardness test and automated grain size, aspect ratio, volume fraction, nodule count and sphericity as well as graphite size distribution determination.

Major devices used in the laboratory:
Specimen cutting and mounting, mechanical and electrolytic polishing, macro and micro etching facilities. Various optical microscopes namely Nikon, Olympus and Vickers research microscopes with digital camera attachments, microhardness tester with Vickers and Knoop indenters, Clemex Image Analysis System.

X-Ray Laboratory

X-Ray Laboratory has three diffractometers for materials characterization.

Major devices used in the laboratory:
Rigaku D/MAX 2200 ULTIMA/PC equipped with theta-theta goniometer with multi-purpose sample attachment allowing a variety of measurements including texture and residual stress, Rikagu DMAX/IIIC Diffraction unit with theta-2-theta goniometer, Bruker D8 Advance equipped with Anton Paar HTK 16N hot stage capable of measurements up to 1500 °C.

Thermal Analysis Laboratory

It is dedicated for thermal analysis, quantitative and qualitative calorimetric studies.

Major devices used in the laboratory:
Setaram DSC 131 thermal analyzer for temperatures of -170 °C to 600 °C, Setaram SETSYS TGDTA/ DSC thermal analyzer with facilities for simultaneous TG and DTA/DSC measurements for temperatures from ambient to 1650 °C.

Instrumental Analysis and Wet Chemical Analysis Laboratory

Instrumental Analysis and Wet Chemical Analysis Laboratory is a facility dedicated to carbon, sulfur, oxygen, hydrogen and nitrogen analysis in ferrous and nonferrous alloys. Standard equipment for volumetric and gravimetric wet chemical analyses are also available.

Major devices used in the laboratory:
Perkin Elmer Atomic Absorption Spectrophotometer, Perkin-Elmer Gas Chromatograph, Satmagan magnetite analyzer, pH meter, a spectrometer, two photometers, turbidimeters, and Leco for analysis of carbon, sulfur, oxygen, hydrogen and nitrogen.

Machine Shop

It serves to implement the research needs of faculty members and graduate students.

Major devices used in the laboratory:
Lathes, a milling machine, a surface grinding machine, a shaping machine, various drills, and various welding equipment.

Faculty

Mahmut Vedat Akdeniz

Professor of Metallurgical and Materials Engineering

Ph.D.: The Open University, UK, 1989
M.S: Middle East Technical University, 1986
B.S: Middle East Technical University, 1983

RESEARCH AREA:
Alloy Design and Development, Bulk Amorphous/Nanocrystalline Alloys, Nanoalloys, Super Alloys, Advanced Magnetic Materials, Intermetallics, Rapid Solidification, Metallic Glasses

PUBLICATIONS:
• Eriş, R., Akdeniz, M.V. & Mekhrabov, A.O. The Site Preferences of Transition Elements and Their Synergistic Effects on the Bonding Strengthening and Structural Stability of γ′-Ni3Al Precipitates in Ni-Based Superalloys: A First-Principles Investigation. Metall Mater Trans A 52, 2298–2313 (2021).
• Akdeniz Mahmut Vedat and Mehrabov Amdulla (2019). Size dependent stability and surface energy of amorphous FePt nanoalloy, Journal of Alloys and Compounds, Vol. 788, pp. 787-798 (DOI: 10.1016/j.jallcom.2019.02.271)
• Eriş Rasim, Akdeniz Mahmut Vedat, Mehrabov Amdulla, (2019). Atomic size effect of alloying elements on the formation, evolution and strengthening of gamma'-Ni3Al precipitates in Ni-based superalloys, Intermetallics, Vol. 109 pp. 37-47 (DOI: 10.1016/j.intermet.2019.02.017)

M. Kadri Aydınol

Professor of Metallurgical and Materials Engineering

Post-doc: Mater Sci and Eng Dept, Massachusetts Institute of Technology (1994-1998)
Ph.D.: Middle East Technical University, 1994
M.S: Middle East Technical University, 1991
B.S: Middle East Technical University, 1989

RESEARCH AREA:
Atomistic Computer Modeling of Materials: ab-initio Methods, Monte Carlo and Molecular Dynamics Simulations. Energy Storage Materials and Devices: Lithium-ion, Ni-MH, Lead-acid and Silver-Zinc Batteries, Hydrogen Storage Alloys and Compounds, Electrochemistry of Materials: Corrosion of Materials and Corrosion Testing and Control.

PUBLICATIONS:
• B. Arslan Hamat and M.K. Aydınol, "Experimental investigation on the electrocatalytic behavior of Ag-based oxides, Ag2XO4 (X=Cr, Mo, W), for the oxygen reduction reaction in alkaline media". Journal of Solid State Chemistry, 290, 121571 (2020).
• B. Pişkin, C.S. Uygur and M.K. Aydınol, "Morphology effect on electrochemical properties of doped (W and Mo) 622NMC, 111NMC, and 226NMC cathode materials". International Journal of Hydrogen Energy, 45, 7874 (2020).

Arcan F. Dericioğlu

Professor of Metallurgical and Materials Engineering

Post-doc: National Institute for Materials Science, Japan (2003-2005)
Post-doc: Inst. of Industrial Science, The University of Tokyo (2002-2003)
Ph.D.: The University of Tokyo, Japan, 2002
M.S: Middle East Technical University, 1999
B.S: Middle East Technical University,1997

RESEARCH AREA:
Additive manufacturing of metallic materials and composites. Electromagnetic wave absorbing materials. Natural and bio-inspired composites. Phase transformations and interfaces. Heat Treatment and microstructural control. Ceramic and ceramic matrix composite processing. Nanostructured coatings and surface composites. Mechanical characterization.

PUBLICATIONS:
• Doğu, M. N., Esen, Z., Davut, K., Tan E., Gümüş, B. and Dericioglu, A. F., "Microstructural and texture evolution during thermo-hydrogen processing of Ti6Al4V alloys produced by electron beam melting," Materials Characterization, vol. 168, 110549 (2020).
• Esen, Z., Öcal, E. B., Akkaya, A., Gürçay, B., Özcan, C., Özgümüş, B. A., Duygulu, Ö. and Dericioğlu, A. F., "Corrosion behaviours of Ti6Al4V-Mg/Mg-Alloy composites," Corrosion Science, vol. 166, 108470 (2020).

Faculty

Caner Durucan

Professor of Metallurgical and Materials Engineering

Post-doc: Center for Nanoscale Science, NSF-Materials Researc and Engineering Center, Penn State Univ. (2003-2005)
Ph.D.: Pennsylvania State University, USA, 2003
M.S: Pennsylvania State University, USA, 1998
B.S: Middle East Technical University, 1993

RESEARCH AREA:
Biomedical Materials, Bioceramics, Calcium Phosphates, Glass Surfaces, Interfaces and Coatings, Sol-Gel Chemistry (silicates, organic-inorganic hybrid systems)

PUBLICATIONS:
• Kahremanoglu K., Temel E.R., Korkut T.E., Nalbant A.A., Azer B.B., Durucan C., Volkan M., Boyaci, E. "Development of a solid-phase microextraction LC-MS/MS method for determination of oxidative stress biomarkers in biofluids" Journal of Separation Science 43, 1925-1933, 2020.
• Kapusuz D., Durucan C., "Exploring encapsulation mechanism of DNA and mononucleotides in sol-gel derived silica" Journal of Biomaterials Applications 32, 114-125, 2017.
• Yuksel R., Durucan C., Unalan, H.E. "Ternary nanocomposite SWNT/WO3/PANI thin film electrodes for supercapacitors" Journal of Alloys and Compounds 658, 183-189, 2016.

C. Hakan Gür

Professor of Metallurgical and Materials Engineering

Ph.D.: Middle East Technical University, 1995
Researcher: BAM-Berlin (1991-1992, 06-09.1993)
M.S: Middle East Technical University
B.S: Middle East Technical University

RESEARCH AREA:
Nondestructive Testing and Materials Characterization, Determination of Residual Stresses, Heat Treatment, Welding

PUBLICATIONS:
• Mashhuriazar A., Omidvar H., Sajuri Z., Gür CH, Baghdadi A.H., Effects of Pre-weld Heat Treatment and Heat Input on Metallurgical and Mechanical Behaviour in HAZ of Multi-pass Welded IN-939 Superalloy, Metals, 10 (2020) 1453.
• Kaleli T, Gür CH, Determination of Surface Residual Stresses in the Carburized AISI 8620 Steel by Magnetic Barkhausen Noise Method, Insight – NDT and Condition Monitoring, 7 (2020) 416.
• Gür CH, Review of Residual Stress Measurement by Magnetic Barkhausen Noise Technique, Materials Performance and Characterization, 7 (2018) 504.
• Gür CH, J.S.Pan (Editor), Handbook of Thermal Process Modeling of Steels, 712 pages, Dec 2008, CRC-Press, ISBN 978-0-8493-5019-1

Rıza Gürbüz

Professor of Metallurgical and Materials Engineering

Ph.D.: Middle East Technical University, 1987
M.S: Middle East Technical University, 1982
B.S: Middle East Technical University, 1979

RESEARCH AREA:
Mechanical Behavior of Materials, Fracture and Fatigue, Failure Analysis, Mechanical Testing of Materials, Tests of Railway Components.

PUBLICATIONS:
• Fatigue Behavior of Welded API 5L X70 Steel Used in Pipelines, Ş.O.Turhan, A. Motemani, R. Gürbüz, Journal of Failure Analysis and Prevention, 20 (2020) 1554–1567.
• Biomechanical Evaluation of a Novel Apatite-Wollastonite Ceramic Cage Design for Lumbar Interbody Fusion: A Finite Element Model Study,C. Bozkurt, A. Senköylü, E. Aktas, B. Sarıkaya, S. Sipahioglu, R.Gürbüz, and M. Timucin, BioMed Research International, Vol. 2018, Article ID 4152543 (2018).
• A Pilot Study of Joint Stability at the Zirconium or Titanium Abutment/Titanium Implant Interface", Y. Çavusoglu, K.Akca, R.Gürbüz, M. C. Cehreli, The International Journal of Oral & Maxillofacial Implants, Vol.29, Issue 2 (2014).
•Evaluation of fatigue performance of a fillet rolled diesel engine crankshaft", G. Cevik, R. Gurbuz, Engineering Failure Analysis, 27 (2013) 250-261.

Faculty

Ali Kalkanlı

Professor of Metallurgical and Materials Engineering

Post-doc: Postdoc, The University of Nottingham, UK,1993
Ph.D.: Ph.D. The Open University Milton Keynes, U.K, 1992
M.S: M.S. Middle East Technical University, 1985
B.S: B.S. Middle East Technical University, 1982

RESEARCH AREA:
Rapid Solidification, Powder Metallurgy, Melting and Casting Cast Iron Solidification, Magnets and Metal Matrix

PUBLICATIONS:
• Effect of solidification rate on microstructure and primary carbides of AISI DC 53 cold work tool steel(2019) İsmail Seçkin Çardaklı and Ali Kalkanlı China Foundry Vol.16, No.3 May,pp 211-216
• Refinement of Primary Carbides in AISI DC 53 Cold Work Tool Steel by Thin Section Copper Permanent Mould Casting and Water Atomization(2019) Seckin Çardaklı and Ali Kalkanlı International Journal of Cast Metals Research Vol. 32, No. 3, pp. 145-153
• Investigation of atmospheric corrosion layers on historic iron nails by micro-Raman spectroscopy(2016) Yucel, Nurdan, Kalkanli Ali, Caner-Saltık, Emine N, Journal of Raman Spectroscopy Volume: 47 Issue: 12 Special Issue: SI pp: 1486-1493

İshak Karakaya

Professor of Metallurgical and Materials Engineering

Post-doc: McGill University and Royal Military College, Canada, 1985
Ph.D.: McGill University, Canada, 1985
M.S: McGill University, Canada, 1981
B.S: Middle East Technical University, 1978

RESEARCH AREA:
Thermochemistry of Molten Oxide, Salt and Alloy Systems, Electrometallurgy of Light Metals, High Temperature Corrosion of Alloys, Computer Modelling of Phase Diagrams

PUBLICATIONS:
• B. Cagan, M. Erdogan, C. Yılmaz, E.B. Yurdakul, and I. Karakaya, 2020. Investigation of Au-Ag-Cu Alloy Electrodeposition to Electromechanical Systems, ECS Transactions, 97 (7) 485-490. https://doi.org/10.1149/09707.0485ecst
• O. Yilmaz, M. Erdogan, I. Karakaya, 2020. Combined Effects of ALS and SLS on Al_2O_3 Reinforced Composite Nickel Coatings, SURFACE ENGINEERING, 36:5, 477-484. https://doi.org/10.1080/02670844.2018.1552503
• BASARAN, Caner, and İshak Karakaya. 2019. "Effects of Pulse Electroplating Parameters on Return Loss (S11) and Surface Roughness of Silver Coatings." ECSarXiv. April 24. https://doi.org/10.1149/osf.io/84qzx.

Cevdet Kaynak

Professor of Metallurgical and Materials Engineering

Post-doc: Cambridge University, UK,1996
Ph.D.: Middle East Technical University, 1994
M.S: Middle East Technical University, 1988
B.S: Middle East Technical University, 1985

RESEARCH AREA:
Development of Polymer Based Nanocomposites for Engineering Applications

PUBLICATIONS:
• U. Can and C. Kaynak, "Performance of Polylactide against UV Irradiation: Synergism of an Organic UV Absorber with Micron and Nano-sized TiO2", Journal of Composite Materials, 54 (18) , 2489-2504 , (August 2020)
• E. Avil, F. Kadioglu and C. Kaynak, "Contribution of Carbon Nanotubes to Vibration Damping Behavior of Epoxy and its Carbon Fiber Composites", Journal of Reinforced Plastics and Composites, 39 (7-8) , 311-323 , (April 2020)
• U. Can and C. Kaynak, "Effects of Micro-Nano Titania Contents and Maleic Anhydride Compatibilization on the Mechanical Performance of Polylactide", Polymer Composites, 41 (2) , 600-613 , (February 2020)

Faculty

Amdulla Mekhrabov

Professor of Metallurgical and Materials Engineering

Post-doc: Lomonosov Moscow State University and Tokyo University and University of California
Dr.Sc.: Tbilisi State University, 1989
Ph.D.: Lomonosov Moscow State University, 1978
B.Sc: Azerbaijan State University

RESEARCH AREA:
Alloy-Design; Metal & Alloy Physics, Computational Materials Science, Intermetallics & Atomic/Magnetic Ordering, Bulk Amorphous/Nanocrystalline Materials, Metal Hydrides & Hydrogen Storage Materials, Magnetic & Magnetocaloric Materials

PUBLICATIONS:
• Eris R., Akdeniz M.V. and Mekhrabov A.O, 2021. The site preferences of transition elements and their synergistic effects on the strengthening and structural stability of γ'-Ni3Al-X precipitates in Ni-based superalloys: A first-principles investigation, Metallurgical and Materials Transactions A,, vol. 52, pp. 2298-2313
• Akdeniz M.V. and Mekhrabov A.O. 2019. Size dependent stability and surface energy of amorphous FePt nanoalloy. J. of Alloys and Compounds, vol. 788, pp.787-798
• Eris R., Akdeniz M. V. and Mekhrabov A. O. 2019. Atomic size effect of alloying elements on the formation, evolution and strengthening of γ'-Ni3Al precipitates in Ni-based superalloys. Intermetallics, vol. 109, pp. 37–47

Bilgehan Ögel

Professor of Metallurgical and Materials Engineering

Post-doc: Mechanical Eng. Dept., University of Bradford (1990-1992)
Ph.D.: Middle East Technical University, 1990
M.S: Middle East Technical University, 1984
B.S: Middle East Technical University, 1982

RESEARCH AREA:
Microstructure-Property Relationships Failure Analysis and Heat Treatment of Metals, Powder Metallurgy

PUBLICATIONS:
• POYRAZ O., OGEL B., Recrystallization, grain growth and austenite formation in cold rolled steels during intercritical annealing, Journal of Materials Research and Technology, vol.9 n.5, 2020, 11263-11277
• UBEYLI M., DENIZ H., DEMIR T., OGEL B., GUREL B., KELES O., Ballistic impact performance of an armor material consisting of alumina and dual phase steel layers Materials & Design, vol.32, n.3, (March 2011), pp.1565-1570.

Abdullah Öztürk

Professor of Metallurgical and Materials Engineering

Ph.D.: University of Missouri Rolla, 1991
M.S: University of Missouri Rolla, 1987
B.S: Istanbul Technical University, 1983

RESEARCH AREA:
Production, Properties and Characterization of Ceramics, Glasses and Glass Ceramics, Ceramic Matrix Composites

PUBLICATIONS:
• E. Burak Ertuş, Çekdar Vakıfahmetoğlu, Abdullah Öztürk, "Enhanced Methylene Blue Removal Efficiency of TiO2 Embedded Porous Glass", The Journal of the European Ceramic Society, Article in press, 2020.
• Pelin Gündoğmuş, Jongee Park, Abdullah Öztürk, "Preparation and Photocatalytic Activity of g- g-C3N4/TiO2 Heterojunctions Under Solar Light Illumination" Ceramics International, Vol. 46, 21431-21438, 2020.
• Asmae Bouziani, Jongee Park, Abdullah Öztürk, "Synthesis of α-Fe2O3/TiO2 heterogeneous composites by the sol-gel process and their photocatalytic activity" Journal of Photochemistry and Photobiology A: Chemistry, 400, 112718-112725, 2020.

Faculty

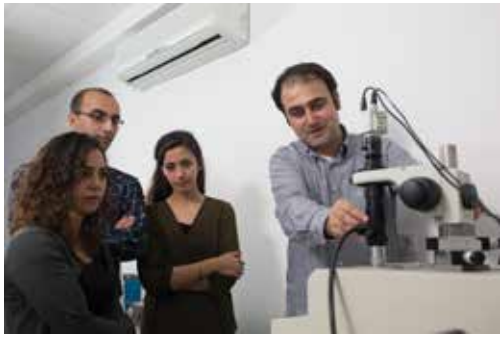
H. Emrah Ünalan

Professor of Metallurgical and Materials Engineering

Post-doc: University of Cambridge (UK), Electrical Engineering, 2008
Ph.D.: Rutgers University (USA), 2006
M.S: Rutgers University (USA), 2004
B.S: Middle East Technical University, 2002

RESEARCH AREA:
Flexible Electronics, Organic Electronics and Semiconducting Devices, Nanowires and Carbon Nanotubes, Solar cells, Light Emitting Diodes and Batteries

PUBLICATIONS:
• A Point-of-Use (POU) Water Disinfection: Silver Nanowire Decorated Glass Fiber Filters, E. Bahcelioglu, D. Doganay, S. Coskun, H.E. Unalan, T. H. Erguder, Journal of Water Process Engineering 38 (2020) 101616.
• All Solution Processed, Oxidation Resistant Copper Nanowire Networks for Optoelectronic Applications with Year Long Stability, S. Polat Genlik, D. Tigan, Y. Koçak, K.E. Ercan, M. O. Cicek, S. Tunca, S. Koylan, S. Coskun, E. Ozensoy, H.E. Unalan, ACS Appl. Mater. Interfaces 12 (2020) 45136.
• Facile Preparation of Nanoparticle Based SERS Substrates for Trace Molecule Detection, O. Demirtas, D.Doganay, I.M. Ozturk, H.E. Unalan, A. Bek, Phys. Chem. Chem. Phys. 22 (2020) 21139.



Y. Eren Kalay

Professor of Metallurgical and Materials Engineering

Post-doc: Ames Lab. and Argonne National Lab. (2009-2010)
Ph.D.: Iowa State University, 2009
M.S: Middle East Technical University, 2003
B.S: Middle East Technical University, 2001

RESEARCH AREA:
Analytical Electron Microscopy (TEM, SEM), Electron/X-ray Spectroscopy, X-ray Scattering (Conventional and Synchrotron X-ray Diffraction), Microstructural Kinetics, Nucleation, Growth and Phase Transformations in Alloys, Metallic Glasses

PUBLICATIONS:
• Ulucan T.H., Kalay İ., Kalay Y.E., "The Anomalous Nucleation in Al-Tb Metallic Glasses", Metallurgical and Materials Transactions A: Physical Metallurgy and Materials Science, Volume 52, Issue 2, Pages 700 – 710, 2021.
• Kalay Y.E, Kalay İ., Hwang J., Voyles P.M., Kramer M.J., "Local chemical and topological order in Al-Tb and its role in controlling nanocrystal formation", Acta Materialia, Volume 60, Issue 3, Pages 994 - 1003, 2012.
• Hwang J., Melgarejo Z.H., Kalay Y.E., Kalay İ., Kramer M.J., Stone D.S., Voyles P.M., "Nanoscale structure and structural relaxation in Zr50Cu 45Al 5 bulk metallic glass", Physical Review Letters, Volume 108, Issue 1911, 2012.

Batur Ercan

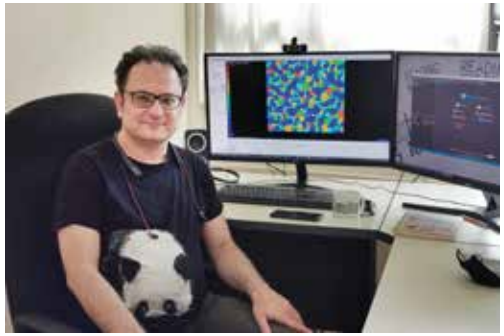
Associate Professor of Metallurgical and Materials Engineering

Post-doc: Northeastern University, MA, USA (2013-2014)
Post-doc: Harvard Medical School, MA, USA (2011-2013)
Ph.D.: Brown University, RI, USA, 2011
M.S: Purdue University, IN, USA, 2005
B.S: Middle East Technical University, 2003

RESEARCH AREA:
Biomaterials, Surface Treatments and Coatings, Nanomaterials Tissue Engineering, Cell-Material Interactions

PUBLICATIONS:
• Ç. M Oral, B. Ercan and D. Kapusuz "Calcium carbonate polymorph dictates in vitro osteoblast proliferation", Journal of the Australian Ceramic Society, (2020), https://doi.org/10.1007/s41779-020-00492-y.
• Ç. M Oral, A. Çalışkan, D. Kapusuz and B. Ercan, "Facile control of hydroxyapatite particle morphology by utilization of calcium carbonate templates at room temperature", Ceramics International, 46, 13, 21319-21327, (2020).
• E. Uslu, H. Öztatlı, B. Garipcan and B. Ercan, "Fabrication and cellular interactions of nanoporous tantalum oxide", Journal of Biomedical Materials Research Part B: Applied Biomaterials, 1-11, (2020), https://doi.org/10.1002/jbm.b.34604.

Faculty



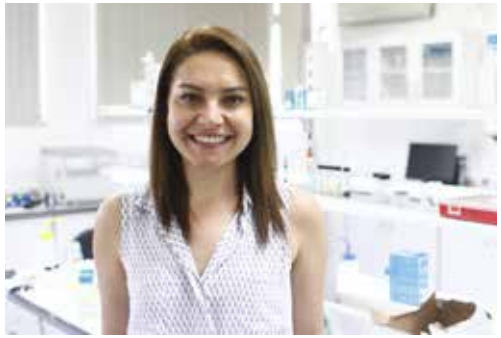
Caner Şimşir

Associate Professor of Metallurgical and Materials Engineering

Post-doc: Leibniz-Institut für Werkstofforientierte Technologien (IWT-Bremen) (2008-2011)
Ph.D.: Middle East Technical University, 2008
M.S: Middle East Technical University, 2002
B.S: Middle East Technical University, 2000

RESEARCH AREA:
Integrated Computational Materials Engineerin (ICME), Numerical and Physical Simulation of Manufacturing Processes, Heat Treatment, Metal Forming, Welding, Residual Stresses

PUBLICATIONS:
• M. Cobanoglu., R.K. Ertan, C. Şimşir, M. Efe "Excessive Damage Increase in Dual Phase Steels under High Strain Rates and Temperatures" International Journal of Damage Mechanics, 2020, DOI : 10.1177/10567895209580531
• C. Şimşir., D. Duran "A Flow-stress Model for Steel in Cold Forging Process Range and the Associated Method for Parameter Identification", International Journal of Advanced Manufacturing Technology 94(9) (2018) 3795-3808
• B. Bayramin, M. Efe, C. Şimşir "Dynamic Strain Aging in DP steels at Forming Relevant Strain Rates and Temperatures" Materials Science and Engineering A (2017), 704, 164-172 280-291



Simge Çınar Aygün

Assist. Professor of Metallurgical and Materials Engineering

Post-doc: Materials Sci. & Engineering/Mechanical Engineering, Iowa State University, 2014 - 2016
Ph.D.: Materials Sci. & Engineering, Iowa State University, 2013
M.S: Middle East Technical University, Chemical Eng., 2009
B.S: Middle East Technical University, Chemical Eng., 2008

RESEARCH AREA:
Colloid and Interface Science, Micro/Nano-particle Synthesis (Ceramic, Metal, Polymer, Multicomponent Particles), Rheology, Flow-assisted Suspension Batteries, Additive Manufacturing of Ceramics

PUBLICATIONS:
• Kayacı H.U., Çınar S., Ceramics International, 46 [12], 20357-68 (2020).
• Chang B.S., Thomas B., Chen J., Tevis I.D., Karanja P., Çınar S., Venkatesh A., Rossini A.J., Thuo M.M., Nanoscale, 11 [29], 14060-69 (2019).
• Oyola-Reynosa S., Tevis I.D., Chen J., Chang B., Çınar S., Bloch J.F., Thuo M., Journal of Materials Chemistry, 4 [38], 14729-38 (2016).

Bilge İmer

Assist. Professor of Metallurgical and Materials Engineering

Post-doc: University of California Santa Barbara, Materials (2006-2007)
Ph.D.: Materials, University of California Santa Barbara, 2006
M.S: Business Economics, University of California Santa Barbara, 2006
B.S: University of Pittsburgh, PA – USA (Transferred from Middle East Technical University, 2000)

RESEARCH AREA:
Thin film material (functional coatings, device structure) growth, Bulk crystal growth, Device and nano-structured materials clean-room processing, modeling, simulation and testing.

PUBLICATIONS:
• "Core/shell copper nanowire networks for transparent thin film heaters", D. Tigan, S.P. Genlik, B.Imer, H. E. Unalan, Nanotechnology, Vol. 30, Number 32, May 2019
• "Nonalloyed Ohmis Contacts in AlGaN/GaN HEMTs with MOCVD Regrowth of InGaN for Ka Band Applications", Huseyin Cakmak, Mustafa Ozturk, Ekmel Ozbay, and Bilge Imer, IEEE Transactions on Electron Devices, TED-2020-11-2558-R
• "ALD Grown AZO contacts for AlGaN/GaN HEMT Device Applications", Huseyin Cakmak Hulya Esen, Dogan Yılmaz, Deniz Tugrul, Ekmel Ozbay and Bilge Imer, Proceedings of International Conference on Advanced Materials Science & Engineering and High-Tech Device Applications, October 2020

Faculty

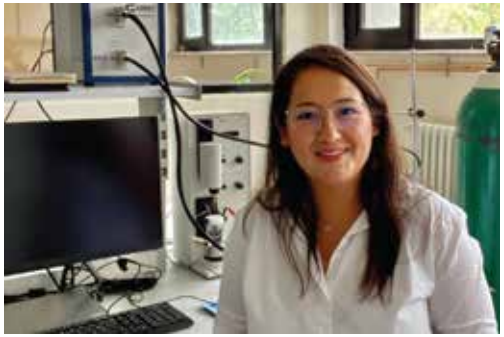
Eda Aydoğan Güngör

Assist. Professor of Metallurgical and Materials Engineering

Post-doc: Los Alamos National Lab. / Materials Science and Technology Division (2016–2018)
Ph.D.: Texas A&M University/College Station/ Materials Science and Engineering, 2016
M.S: Middle East Technical University, 2012
B.S (Minor): Middle East Technical University, Mechanical Engineering, 2011
B.S: Middle East Technical University, 2010

RESEARCH AREA:
Radiation damage in nuclear materials, Processing techniques to produce heat and radiation resistant materials, Characterization of damage structures in materials, Diffraction techniques to analyze texture and deformation in metals, Metal additive manufacturing

PUBLICATIONS:
• Y. Cui, E Aydogan, J.G. Gigax, Y.Q. Wang, A. Misra, S.A. Maloy, N. Li, 'In Situ Micro-Pillar Compression to Examine Radiation-Induced Hardening Mechanisms of FeCrAl Alloys', Acta Materialia, 202 (2021) 255-265.
• E. Aydogan, J. Gigax, S. Parker, B. Eftink, M. Chancey, J. Poplawsky, S. Maloy 'Nitrogen effects on radiation response in 12Cr ferritic/martensitic alloys', Scripta Materialia, 189 (2020) 145-150.



Çiğdem Toparlı

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RESEARCH AREA:
Electrochemistry, electrocatalysis, energy conversion and storage, corrosion and environmental effects, materials chemistry, surfaces, interfaces, and thin Films

PUBLICATIONS:
• C. Nicollet, C.Toparli, G. F. Harrington, T. Defferriere, B. Yildiz, H. L. Tuller, "Acidity of Surface Infiltrated Binary Oxides as a Sensitive Descriptor of Oxygen Exchange Kinetics in Mixed Conducting Oxides" (2020) Nature Catalysis, 3, 913–920 (2020)
• E. Lokcu, C. Toparli, M. Anik, "Electrochemical performance of (MgCoNiZn) 1-xLixO high entropy oxides in lithium ion batteries", ACS Applied Materials & Interfaces 12 (21) (2020), 23860–23866.

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PUBLICATIONS:
• Y. Kelestemur, Y. Shynkarenko, M. Anni, S. Yakunin, M. L. De Giorgi, M. V. Kovalenko, Colloidal CdSe Quantum Wells with Graded Shell Composition for Low-Threshold Amplified Spontaneous Emission and Highly Efficient Electroluminescence, ACS Nano, 13, 13899, 2019.
• Y. Kelestemur, D. Dede, K. Gungor, C. F. Usanmaz, O. Erdem, and H. V. Demir, Alloyed heterostructures of CdSexS1-x nanoplatelets with highly tunable optical gain performance, Chemistry of Materials, 29, 4857, 2017.
• Y. Kelestemur, B. Guzelturk, O. Erdem, M. Olutas, K. Gungor, and H. V. Demir, Platelet-in-box colloidal quantum wells: CdSe/CdS@CdS core/crown@shell heteronanoplatelets, Advanced Functional Materials, 26, 3570, 2016.

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