



# MATERIALS ENGINEERING Industry Guide

## Introduction

Materials Engineering is a dynamic and interdisciplinary field that focuses on understanding and improving the properties of materials to enhance their performance in various applications. At UBC, this program combines science, engineering, and innovation to address challenges in material selection, development, and sustainability.

Materials engineers play a crucial role in industries such as aerospace, automotive, energy, construction, electronics, medical devices, and more. They are instrumental in developing new materials, optimizing existing ones, and ensuring their effective use in products and systems. Just look around—materials are the foundation of everything we use!

This document provides an overview of the industries and companies where materials engineers may find opportunities. While not exhaustive, it draws on insights from personal experience, discussions with UBC MATL alumni, and online research to present generalized descriptions of each industry.

### Key Areas of Study

- Materials Science, Thermodynamics, Physical Metallurgy, Polymer Engineering, Ceramics, Composite Materials, Biomaterials, Nanotechnology, Advanced Alloys, Sustainable Materials, Functional Materials, Surface Engineering, Materials Characterization, Failure Analysis, Computational Materials Science, Additive Manufacturing, Corrosion and Wear, Mechanical Testing, Heat Treatment, and Process Modeling.

## Industries

Materials Engineering plays a fundamental role across numerous industries, driving innovation and enabling technological advancements. In the aerospace sector, materials engineers develop lightweight, high-strength materials that improve fuel efficiency and withstand extreme conditions. The automotive industry relies on them to create advanced alloys and composites for safer, more sustainable vehicles. In electronics, materials engineers design semiconductors, conductive polymers, and other specialized materials that power modern devices. The energy sector benefits from their expertise in developing materials for renewable energy systems, such as high-efficiency solar panels and durable wind turbine components. In construction, they improve materials like concrete, steel, and composites to enhance durability, sustainability, and performance.

In healthcare, materials engineers contribute to the development of biocompatible materials used in implants, prosthetics, and medical devices. They also play a critical role in the packaging industry, designing sustainable and innovative materials to reduce waste. Emerging fields such as nanotechnology and 3D printing depend on materials engineers to explore and create groundbreaking solutions for next-generation applications. These diverse industries demonstrate the pivotal impact of materials engineering in shaping the future of technology and society.

# Industries

## AEROSPACE AND DEFENSE

Materials engineering in the aerospace and defense industry is crucial for developing high-performance materials that meet the stringent requirements of flight, space exploration, and defense applications. Materials engineers focus on designing and testing lightweight, durable, and heat-resistant materials for aircraft, spacecraft, and military systems. They ensure that materials perform optimally under extreme conditions, including high stress, temperature fluctuations, and exposure to harsh environments.

In this field, materials engineers work on innovations such as advanced composites for aircraft structures, heat-resistant alloys for jet engines, and radiation-resistant materials for space missions. They also contribute to the development of materials for missile defense systems, satellites, and autonomous defense technologies. This industry demands expertise in materials selection, testing, and performance modeling to ensure safety, reliability, and mission success.

### ESSENTIAL SKILLS:

- Materials Selection for High-Performance Applications
- Advanced Composite Materials and Metallurgy
- Thermal Management and Heat-Resistant Materials
- Structural Integrity and Failure Analysis
- Knowledge of Aerospace Standards and Certifications

### POSITIONS:

- Entry Level: Materials Engineer, Aerospace Materials Analyst
- Mid-Level: Materials Testing Engineer, Composite Materials Specialist
- Senior: Senior Materials Engineer, Lead Aerospace Materials Scientist, Materials Program Manager

## AUTOMOTIVE

In the automotive industry, materials engineering plays a pivotal role in the development of innovative materials that enhance vehicle performance, safety, and sustainability. Materials engineers in automotive design and manufacturing are responsible for selecting, testing, and optimizing materials that meet stringent safety standards, reduce weight for fuel efficiency, and provide durability over the lifespan of a vehicle. They also work on advanced manufacturing techniques such as additive manufacturing, and develop new materials that enable electric vehicles (EVs) and autonomous driving technologies. Materials engineers in the automotive sector focus on lightweight metals, high-strength steels, polymers, composites, and sustainable materials that can be used for vehicle body components, powertrains, and batteries. Their work contributes to improving crash performance, increasing fuel efficiency, and reducing the environmental impact of vehicles.

### ESSENTIAL SKILLS:

- Lightweight Materials and Alloy Development
- Knowledge of Automotive Safety Standards and Regulations
- Sustainability in Automotive Materials
- Advanced Composites and Polymer Engineering
- Materials Testing and Failure Analysis

### POSITIONS:

- Entry Level: Automotive Materials Engineer, Junior Materials Testing Specialist
- Mid-Level: Senior Materials Engineer, Composite Materials Specialist, Battery Materials Engineer
- Senior: Lead Automotive Materials Scientist, Materials Development Manager, Automotive R&D Director

## ELECTRONICS AND SEMICONDUCTORS

Materials engineering in the electronics and semiconductor industry focuses on developing and optimizing materials that are essential for the performance of electronic devices and semiconductor components. Materials engineers in this field work with materials at the atomic and molecular levels to design semiconductors, insulators, conductors, and magnetic materials used in everything from microchips to displays and sensors. Their expertise is key to enhancing the functionality, efficiency, and reliability of electronic devices.

In the electronics industry, materials engineers focus on selecting and processing materials that optimize electrical conductivity, heat dissipation, and signal integrity. In semiconductors, they work on materials such as silicon, gallium arsenide, and advanced compounds for integrated circuits, transistors, and memory devices. With the rapid advancement of electronics, materials engineers are also involved in the development of novel materials for flexible electronics, photonics, and wearable devices.

### ESSENTIAL SKILLS:

- Semiconductor Materials and Device Fabrication
- Thin Film Deposition and Lithography
- Electrical Conductivity and Thermal Management
- Material Characterization and Testing Techniques
- Knowledge of Electronic Packaging Materials

### POSITIONS:

- Entry Level: Semiconductor Materials Engineer, Electronics Materials Testing Specialist
- Mid-Level: Materials Process Engineer, Device Materials Development Specialist
- Senior: Senior Semiconductor Materials Scientist, Electronics R&D Manager, Materials Engineering Director

# Industries

## HEALTHCARE AND BIOMEDICAL

Materials engineering in healthcare and biomedical applications focuses on developing advanced materials that are critical for medical devices, implants, prosthetics, and diagnostics. Materials engineers in this field ensure that materials used in medical applications are biocompatible, durable, and able to function optimally within the human body. They work on materials designed to interact safely with biological systems while maintaining performance and longevity under physiological conditions.

In healthcare, materials engineers develop materials for prosthetic limbs, dental implants, pacemakers, and drug delivery systems, as well as materials used in medical imaging and diagnostic equipment. As the medical field advances, materials engineers are increasingly focused on the development of smart biomaterials, which can respond to environmental stimuli for personalized treatment.

### ESSENTIAL SKILLS:

- Biocompatibility and Material Testing
- Design of Biomaterials for Implants and Prosthetics
- Advanced Polymers and Composites for Medical Devices
- Tissue Engineering and Regenerative Medicine
- Drug Delivery Systems and Smart Biomaterials

### POSITIONS:

- Entry Level: Biomedical Materials Engineer, Materials Testing Specialist
- Mid-Level: Biomaterials Engineer, Medical Device Materials Specialist, Tissue Engineering Researcher
- Senior: Senior Biomedical Materials Scientist, Lead Medical Device Development Engineer, Director of Biomaterials Research

## ENERGY AND RENEWABLE RESOURCES

Materials engineering in the energy and renewable resources sector focuses on developing and optimizing materials that enhance the performance and efficiency of energy generation, storage, and distribution systems. Materials engineers in this field work on advanced materials that are essential for renewable energy technologies, such as solar cells, wind turbines, and energy storage devices, as well as improving the materials used in traditional energy infrastructure.

In renewable energy, materials engineers develop high-efficiency photovoltaic materials for solar panels, lightweight and durable materials for wind turbine blades, and advanced materials for energy storage devices like batteries and supercapacitors. They also work on materials for fuel cells and bioenergy systems. The goal is to create sustainable materials that can improve the efficiency, longevity, and cost-effectiveness of renewable energy systems, while reducing the environmental impact of energy production.

### ESSENTIAL SKILLS:

- Photovoltaic Materials and Solar Cell Design
- Energy Storage Materials (Batteries, Supercapacitors)
- Wind Energy Materials and Structural Integrity
- Corrosion Resistance and Durability of Energy Systems
- Materials for Fuel Cells and Hydrogen Storage

### POSITIONS:

- Entry Level: Renewable Energy Materials Engineer, Battery Materials Specialist
- Mid-Level: Energy Systems Materials Engineer, Solar Energy Materials Scientist
- Senior: Senior Materials Engineer, Renewable Energy R&D Manager, Director of Energy Materials Research

## CONSTRUCTION AND INFRASTRUCTURE

Materials engineering in the construction and infrastructure industry focuses on developing and optimizing materials that ensure the strength, durability, and sustainability of buildings, bridges, roads, and other infrastructure projects. Materials engineers in this sector work with traditional construction materials such as concrete, steel, and timber, as well as innovative materials like composites and smart materials, to improve performance and reduce environmental impact.

In construction, materials engineers are involved in the selection and testing of materials that enhance structural integrity, durability, and resistance to environmental factors such as moisture, temperature fluctuations, and corrosion. They also work on developing sustainable building materials, such as recycled aggregates, green concrete, and low-impact materials for energy-efficient buildings. Additionally, materials engineers contribute to advancements in infrastructure, including transportation materials, smart sensors embedded in structures, and self-healing materials for bridges and roads.

### ESSENTIAL SKILLS:

- Concrete and Steel Materials Design
- Structural Integrity and Durability Testing
- Sustainable Building Materials and Green Construction
- Corrosion Resistance and Weathering Effects
- Smart Materials and Sensor Integration in Infrastructure

### POSITIONS:

- Entry Level: Construction Materials Engineer, Materials Testing Technician
- Mid-Level: Structural Materials Specialist, Sustainable Building Materials Engineer
- Senior: Senior Materials Engineer, Lead Construction Materials Researcher, Infrastructure Materials Manager

# Industries

## **MATERIALS ENGINEER**

Materials engineers focus on selecting, developing, and evaluating materials to be used in manufacturing processes. They research and test the properties of materials to ensure they meet the necessary quality, safety, and performance standards for specific applications. By understanding the characteristics of various materials, they help optimize product design and manufacturing efficiency.

Collaboration is key, as materials engineers work closely with design, production, and quality teams to ensure that materials are used effectively, cost-efficiently, and sustainably. They play a vital role in the development of new materials and processes that improve product performance and longevity, making their expertise essential in diverse industries, ranging from aerospace to consumer goods.

### ESSENTIAL SKILLS:

- Materials Selection and Testing
- Knowledge of Material Properties and Behavior
- Failure Analysis and Troubleshooting
- Research and Development
- CAD and Simulation Software Proficiency

### POSITIONS:

- Entry Level: Materials Engineer, Materials Analyst
- Mid-level: Senior Materials Engineer, Materials Development Specialist
- Senior: Lead Materials Engineer, Materials Science Manager, R&D Materials Engineer

# Technical Skills

## CORE SKILLS

### MATERIALS CHARACTERIZATION & TESTING

Proficiency in using various techniques to analyze and evaluate material properties, including mechanical testing (tensile, hardness, impact), microstructure analysis (SEM, TEM), and spectroscopy (XRD, FTIR).

### MATERIALS PROCESSING TECHNIQUES

Knowledge in processing methods such as casting, forging, extrusion, welding, heat treatment, and additive manufacturing to manipulate and enhance the properties of metals, polymers, ceramics, and composites for specific applications.

### NANOTECHNOLOGY & ADVANCED MATERIALS

Expertise in designing and developing nanomaterials and other advanced materials, including functional materials and smart materials, for applications in fields like electronics, energy storage, and biomedical devices.

### CORROSION & WEAR RESISTANCE

Understanding the mechanisms of corrosion, oxidation, and wear in various materials and environments, and applying techniques like coatings and surface treatments to improve material durability and longevity.

### BIOMATERIALS & MEDICAL APPLICATIONS

Knowledge in developing biocompatible materials for use in medical devices, implants, and prosthetics, ensuring that materials meet safety standards and function properly in biological environments.

### THERMODYNAMICS & MATERIALS BEHAVIOR

Understanding the thermodynamic principles that govern the behavior of materials under various conditions, including phase changes, heat treatments, and material property optimizations.

### SUSTAINABILITY & GREEN MATERIALS

Familiarity with the design and development of sustainable materials, such as recyclable, biodegradable, or energy-efficient materials, to minimize environmental impact and promote circular economies.

## SOFTWARES AND TOOLS

### MATERIALS CHARACTERIZATION & TESTING TOOLS

- OriginLab, Thermo Scientific: Software for data analysis and visualization of material properties, including thermal, mechanical, and structural testing.
- ImageJ: Image processing software for analyzing microstructure images and performing statistical analysis on material samples.

### FINITE ELEMENT ANALYSIS (FEA) & SIMULATION

- ANSYS, COMSOL, Abaqus: Tools for simulating material behavior under various stress, thermal, and environmental conditions to predict performance and failure.
- MATLAB/Simulink: Used for data analysis, model creation, and simulations of materials' physical behavior and process optimization.

### MATERIALS DESIGN & MODELING SOFTWARE

- MATERIALS Studio, LAMMPS: Software for molecular dynamics and materials modeling, enabling the simulation of material properties at the atomic level.
- SolidWorks, AutoCAD: CAD tools commonly used for designing materials or components, especially in the context of product development and testing.

### MATERIALS DATABASE & SELECTION SOFTWARE

- Granta MI, CES Selector: Materials selection tools that provide access to databases for analyzing and choosing materials based on specific engineering requirements.
- MatWeb: A database for material properties that aids engineers in selecting materials based on their mechanical, thermal, and electrical properties.

### CORROSION & SURFACE TREATMENT TOOLS

- Corrosion Analysis Software: Tools that model and predict corrosion rates, resistance, and material degradation under various conditions.
- SurfaceWorks, KOBOLD: Software designed for simulating and analyzing surface treatments and coatings for improving material performance

## How to get Involved

- Engineering Design Teams:
  - <https://experience.apsc.ubc.ca/student-groups/engineering-design-teams-list>
- UBC Clubs
- EUS: <https://ubcengineers.ca/>
- Personal Projects
- UBC Work Learn Program
  - <https://ubc-csm.symplicity.com/students/app/home>

## Other Resources

- <https://vancouver.calendar.ubc.ca/faculties-colleges-and-schools/faculty-applied-science/bachelor-applied-science/manufacturing-engineering>
- American Ceramic Society (ACerS): <https://ceramics.org/>
- About your degree:
  - <https://students.ubc.ca/career/your-degree/engineering/manufacturing-engineering>