Chronicle Guidance Publications

Materials Engineers

Occupational Brief Title Codes:
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Occupational Subtitles:
- Ceramics Engineers
- Metallurgical Engineers

Work Classification Based Related D.O.T. Occupations:
- Biomedical Engineers
- Laser Technicians
- Logistics Engineers
- Optical Engineers
- Packaging Engineers
- Pollution Control Engineers

Interests Based Related G.O.E. Occupations:
- Cost Analysis Engineers
- Factory Layout Engineers
- Industrial Engineers
- Land Surveyors
- Production Planners
- Time Study Engineers

Skills Based Related O*NET Occupations:
- Civil Engineering Technicians
- Electrical Drafters
- Electrical Engineering Technicians
- Marine Architects
- Mechanical Engineers

Noteworthy Quote:

"Society utilizes and depends on materials for everything from simple eating utensils to the latest high-speed computers. Materials engineers use their knowledge of the structure and behavior of materials to design new materials and to engineer new products to meet the needs of society."

–Professor James M. Howe, Department of Materials Science & Engineering, University of Virginia, Charlottesville, Virginia.

Materials engineers (ma`te-ri-als en-gi`neers) manipulate the atomic and molecular structure of substances to create products ranging from computer chips and television screens to golf clubs and snow skis. They work with metals, ceramics, plastics, semiconductors, and combinations of materials called composites to create new materials that meet certain mechanical, electrical, and chemical requirements. They also test and evaluate existing materials for new applications.

Throughout history people have measured time by the materials nature provides: The Stone Age, The Bronze Age, The Iron Age, and today The Materials Age. These terms reflect an awareness that everything people use is made of materials derived from the earth. Today, materials engineers take the materials that the earth provides, and they combine and alter them in order to make new, stronger, and less expensive materials or composites.

Work Performed

Materials engineers study the structure and composition of materials such as metals, ceramics, plastics, and composites. They also study how materials are made, and how they behave under different conditions. When they begin a project, materials engineers work with others on development of a new or improved product. In choosing materials for the product, they consider strength, weight, design, purpose, performance, method of manufacture, and cost. Once the materials needed for a product or project have been determined, materials engineers plan and set up a laboratory operation to develop the procedures for producing the product.

In the laboratory, materials engineers may find that a material is unsuitable for its intended purpose. They may then decide that they need to use another material in order to achieve their final objective of a useful and reliable product. Sometimes, rather than changing to a new material, they may work to improve the performance of the material they have been using by changing some property such as the strength of the material, its resistance to corrosion, or its ability to withstand stress.

Besides working to change the properties of existing materials and working to create new materials, materials engineers look for ways to reduce costs. They may look for a way to substitute a material that serves the purpose equally well but is more easily available or more easily manufactured than the material that is currently being used for a project or a product.

Materials engineers also follow up on products or materials they have developed. They review product failures and examine test data to confirm or to rule out reasons for the failures. Analyses may point out a need for changes in design, materials, or manufacturing processes.

Materials engineers evaluate the relationship between engineering properties and phenomena associated with a material that is related to its composition and structure; including atoms present and their arrangement in the material. They contribute to the establishment of standard engineering materials, with predictable and reproducible properties.

In their work materials engineers use test and evaluation equipment such as electron microscopes, X-ray diffractometers, mechanical test equipment, and computers. They may use ultrasound devices and other test equipment.

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Metals

Materials engineers who study the nature, structure, and physical properties of metals and their alloys are often called ***metallurgical engineers***. They develop and improve metalworking processes such as casting, forging, rolling, and drawing. Metallurgical engineers work at extracting metals from ores and refining them to obtain useful metal. They refine, alloy, cast, fabricate, and heat-treat metals to meet metals requirements.

Metallurgical engineers work in one of the three main branches of metallurgy. These three branches include extractive or chemical, physical, and process or mechanical. ***Extractive metallurgists*** are concerned with removing metals from ores and refining and alloying them to obtain useful metal. ***Physical metallurgists*** study the nature, structure, and physical properties of metals and their alloys, and methods of processing them into final products. ***Process metallurgists*** develop and improve metalworking processes such as casting, forging, rolling, and drawing.

Ceramics

Materials engineers that work with ceramic materials are called ***ceramics engineers***. Ceramics include all nonmetallic, inorganic materials that generally require high temperatures in their processing. The heat shield tiles on the space shuttle are made of ceramic materials. Many parts of common electronics are ceramics. Replacements for human bones and teeth are also products of materials engineers.

Ceramics engineers produce new applications for existing products. Fiber optics, which are capable of handling much more information and offer less resistance than that of metal cables, are replacing wires in communication systems. Fiber optic phone lines have made it possible for much more communication to travel over the lines while also providing for the most clear communication ever. The efforts of materials engineers have made this possible.

Ceramics engineers also develop new ceramic materials and methods for making ceramic materials into useful products. They work on products as diverse as glassware, automobile and aircraft engine components, tile, and electric insulators.

Plastics

Some materials engineers are called ***plastics engineers***. They work with and develop new applications for plastics. These materials, called polymers, are produced by making chains of carbon by combining molecules. Polymers, an inexpensive commodity, are now used in high technology sectors, for ultra sensitive sonar, temperature and flame retardent fabrics, nonstick sauce pans, reusable pressure-sensitive adhesives, and encapsulants for drug delivery. Plastics can be made hard as stone, strong as steel, transparent as glass, light as wood, and elastic as rubber. Plastics are also lightweight, waterproof, chemical resistant, and produced in almost any color. More than 50 families of plastics have been produced, and new types are currently under development.

Composites

Composites engineers are materials engineers who work with composites to find ways to combine materials to produce a new material with enhanced properties. They may, for instance, weave thin metal fibers into a fabric and cover it with a plastic resin. The result is a lightweight, strong, durable material that combines the properties of base materials with corrosion resistance and flexibility. The Stealth bomber has composite materials that absorb rather than reflect radar waves, making it mostly invisible to radar.

Working Conditions

Materials engineers work in many settings. Much of the time they work in a support group for a manufacturing plant or in a laboratory.

Materials engineers may travel to confer with primary producers of materials such as metals, papers, or plastics. They may travel to mines, steel mills, chemical plants, or other manufacturing plants. They also travel to conventions and meetings to discuss new findings and solutions to problems.

Hours and Earnings

Materials engineers work at least eight hours a day, five days a week. Like other professionals, they often work overtime to meet a deadline or to finish a test or project. If they travel, they may be away from home for days at a time.

The pay of engineers depends on their education and experience. Earnings also vary with the geographical location and the kind and size of the company they work for. According to the Bureau of Labor Statistics, in 2003, material engineers earned an average of $62,930 a year. Earnings ranged from a high of more than $93,280 a year, to a low of less than $40,160 a year. According to a 2003 salary survey by the National Association of Colleges and Employers, Bachelor's degree candidates in materials engineering received starting offers averaging $44,680 a year.

Most companies that hire materials engineers offer good fringe benefits. They give employees paid vacations and holidays, health and life insurance, and pension plans. Many firms offer grants for research and further education.

Education and Training

A bachelor's degree in engineering is required for most engineering jobs. In college, engineering students

study four or five years to earn a bachelor's degree. First year studies include chemistry, mathematics, physics, computer science, English, speech, humanities, and social studies. Students choose a specialty in their second year.

Materials engineering students concentrate on subjects such as crystallography, thermodynamics, material and energy balance, transport phenomena, statics, strength of materials, and electronic circuits. They study the structure and properties of materials, processing of materials, analysis of manufacturing processes, and thermodynamics of condensed systems.

Engineers may go on to earn a graduate degree in engineering. Students working for a graduate degree study a specific part of the field in greater depth and focus on a key problem. They may, for instance, study atomic configurations related to some property of processing. They may inquire into a property related to the structure and processing of materials.

A master's degree requires a year or two of class and laboratory work in a specialty, and a thesis on a topic of engineering importance. To earn a doctorate, engineers must define and study a new or unsolved problem that relates to their specialty. They write a dissertation, or thesis, about their research. Some schools have a nonresearch, nondissertation program for the master's degree.

Licensing, Certification, Unions and Professional Societies

Although laws differ from state to state, engineers whose work affects public health, safety, or property must be registered with the state. Some engineers must also be registered in order to hold certain jobs in industry or government. To be registered, engineers must graduate from an approved engineering school, pass a fundamentals-of-engineering examination, have four years of engineering experience, and then pass a second state examination. Each state has a board of examiners that licenses engineers.

Each engineering specialty has its own society. These professional groups publish papers, set standards for procedures, help members keep up to date in their field, and encourage an interest in engineering among students. Materials engineers may belong to organizations such as The Minerals, Metals, & Materials Society (TMS), ASM International, Materials Research Society (MRS), the Society of Plastics Engineers (SPE), the American Ceramic Society (ACS), the American Society for Testing and Materials (ASTM), or the Society for the Advancement of Material and Process Engineering (SAMPE). Some engineers are members of more than one society.

Most of the technical societies with an interest in the development and application of materials and materials processes have formed the Federation of Materials Societies, which represents their common interests. Some of its member societies are TMS, the American Ceramic Society, American Institute of Chemical Engineers, ASM International, National Association of Corrosion Engineers, and Institute of Electrical and Electronics Engineers.

Personal Qualifications

Engineers should have an inquiring mind, imagination, and logical thought processes. They should be able to work accurately under pressure. They should also have perseverance. Creativity, analytical skills, and a capacity for detail are important.

Materials engineers should have very good communications skills in order to explain their ideas, exchange information, and supervise others. They should be flexible and able to work well with others.

Occupations can be adapted for workers with disabilities. Persons should contact their school or employment counselors, their state office of vocational rehabilitation, or their state department of labor to explore fully their individual needs and requirements as well as the requirements of the occupation.

Where Employed

According to the Bureau of Labor Statistics, about 23,000 materials engineers worked throughout the United States in the year 2003. About 65 percent of them worked in manufacturing industries, mainly computer and electronic products, transportation equipment, fabricated metal products, primary metal production, and machinery manufacturing. Materials engineers also work in aerospace, chemical, automotive, electronic, plastic and package, and recreation industries, as well as firms that make glass, stone, clay, and metal products.

Generally, materials engineers work in or near cities or large industrial centers. Research firms, consulting firms, and government agencies such as the U.S. Department of Defense and the National Aeronautics and Space Administration also employ materials engineers.

Employment Outlook

Employment in the field of materials engineering is expected to grow more slowly than the national average through the year 2012. Many of the manufacturing industries in which materials engineers are concentrated—such as primary metals; industrial machinery and equipment; and stone, clay, and glass products—are expected to experience declines in employment.

On the other hand, employment growth in electronics industries and in services such as research, testing, architectural, and engineering should offer a substantial number of job openings. These companies develop improved materials for their industrial customers.

Entry Methods

Most placement offices at colleges can help students with job leads. Some engineering schools host recruiters from industries who sign up seniors before their graduation.

Business and professional journals, as well as employment agencies, may list job openings. Many professional organizations offer career information, workshops and training, and job listings. Graduates may send letters and resumes to firms that employ materials engineers. Some of these firms run want ads in major newspapers and on the Internet.

Advancement

Small but growing companies may give engineers a broader range of experience than large companies. Large companies with greater resources may offer work on more complex projects, and they offer better prospects for advancement. After several years on the job, materials engineers may head a team project or advance to the management of a department. Those with administrative ability may advance to top management positions.

For Further Research

American Ceramic Society, P.O. Box 6136, Westerville, OH 43086-6136. Visit their Web site at: www.acers.org

American Society for Testing and Materials, 100 Barr Harbor Drive, West Conshohocken, PA 19428-2959. Visit their Web site at: www.astm.org

ASM International, 9639 Kinsman Road, Materials Park, OH 44073-0002. Visit their Web site at: www.asm-intl.org

Federation of Materials Societies, 910 17th Street, NW, Suite 800, Washington, DC 20006. Visit their Web site at: www.materialsocieties.org

Materials Research Society, 506 Keystone Drive, Warrendale, PA 15086-7573. Visit their Web site at: www.mrs.org

The Minerals, Metals & Materials Society, 184 Thorn Hill Rd., Warrendale, PA 15086-7514. Visit their Web site at: www.tms.org

Materials/Metallurgical Engineering: An Exciting Career Field for the Future. Free.

Society for the Advancement of Material and Process Engineering, P.O. Box 2459, Covina, CA 91722. Visit their Web site at: www.sampe.org

Society of Plastics Engineers, 14 Fairfield Drive, Brookfield, CT 06804-0403. Visit their Web site at: www.4spe.org

Acknowledgments

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