

Sources of Additional Information

For information about employment opportunities in photographic laboratories and schools that offer degrees in photographic technology, contact:

- ▶ Photo Marketing Association International, 3000 Picture Place, Jackson, MI 49201.

Semiconductor Processors

(O*NET 51-9141.00)

Significant Points

- Semiconductor processors is the only production occupation whose employment expected to grow much is expected to grow faster than the average for all occupations.
- An associate degree in a relevant curriculum is increasingly required.

Nature of the Work

Electronic semiconductors—also known as computer chips, microchips, or integrated chips—are the miniature but powerful brains of high technology equipment. They are comprised of a myriad of tiny aluminum wires and electric switches, which manipulate the flow of electrical current. Semiconductor processors are responsible for many of the steps necessary to manufacture each semiconductor that goes into a personal computer, missile guidance system, and a host of other electronic equipment.

Semiconductor processors manufacture semiconductors in disks about the size of dinner plates. These disks, called wafers, are thin slices of silicon on which the circuitry of the microchips is layered. Each wafer is eventually cut into dozens of individual chips.

Semiconductor processors make wafers using photolithography, a printing process for creating plates from photographic images. Operating automated equipment, workers imprint precise microscopic patterns of the circuitry on the wafers, etch out the patterns with acids, and replace the patterns with metals that conduct electricity. Then the wafers receive a chemical bath to make them smooth, and the imprint process begins again on a new layer with the next pattern. Wafers usually have from 8 to 20 such layers of microscopic, three-dimensional circuitry.

Semiconductors are produced in semiconductor fabricating plants, or “fabs.” Within fabs, the manufacture and cutting of wafers to create semiconductors takes place in “clean rooms.” Clean rooms are production areas that must be kept free of any airborne matter, because the least bit of dust can damage a semiconductor. All semiconductor processors working in clean rooms—both operators and technicians—must wear special lightweight outer garments known as “bunny suits.” Bunny suits fit over clothing to prevent lint and other particles from contaminating semiconductor processing worksites.

Operators, who make up the majority of the workers in clean rooms, start and monitor the sophisticated equipment that performs the various tasks during the many steps of the semiconductor production sequence. They spend a great deal of time at computer terminals, monitoring the operation of the equipment to ensure that each of the tasks in the production of the wafer is performed correctly. They also may transfer wafer carriers from one development station to the next; in newer fabs, the lifting of heavy wafer carriers and the constant monitoring for quality control are increasingly being automated, however.



Semiconductor processing technicians use microscopes to check for flaws in semiconductor wafers.

Once begun, production of semiconductor wafers is continuous. Operators work to the pace of the machinery that has largely automated the production process. Operators are responsible for keeping the automated machinery within proper operating parameters.

Technicians account for a smaller percentage of the workers in clean rooms, but they troubleshoot production problems and make equipment adjustments and repairs. They also take the lead in assuring quality control and in maintaining equipment. In order to prevent the need for repairs, technicians perform diagnostic analyses and run computations. For example, technicians may determine if a flaw in a chip is due to contamination and peculiar to that wafer, or if the flaw is inherent in the manufacturing process.

Working Conditions

The work pace in cleanrooms is deliberately slow. Limited movement keeps the air in cleanrooms as free as possible of dust and other particles, which can destroy semiconductors during production. Because the machinery sets operators' rate of work in the largely automated production process, workers keep an easy-going pace. Although workers spend some time alone monitoring equipment, operators and technicians spend much of their time working in teams.

Technicians are on their feet most of the day, walking through the clean room to oversee production activities. Operators spend a great deal of time sitting or standing at workstations, monitoring

computer readouts and gauges. Sometimes, they must retrieve wafers from one station and take them to another.

The temperature in the cleanrooms must be kept within narrow ranges, usually a comfortable 72 degrees Fahrenheit. Although bunny suits cover virtually the entire body, except perhaps the eyes, their light-weight fabric keeps the temperature inside fairly comfortable as well. However, entry and exit of workers in bunny suits from the clean room is controlled to minimize contamination, and workers must be reclothed in a clean suit and decontaminated each time they return to the clean room.

The work environment of semiconductor fabricating plants is one of the safest in any industry. Measures taken to avoid contamination of the wafers lead to more than just antiseptically clean rooms—they result in a work environment nearly free of conditions that cause occupational illnesses and accidents.

Semiconductor fabricating plants operate around the clock. For this reason, night and weekend work is common. In some plants, workers maintain standard 8-hour shifts, 5 days a week. In other plants, employees are on duty for 12-hour shifts to minimize the disruption of clean room operations brought about by shift changes. Managers in some plants allow workers to alternate schedules for equitable distribution of the “graveyard” shift.

Employment

Electronic semiconductor processors held 52,000 jobs in 2000. Nearly all of them were employed in facilities that manufacture electronic components and accessories, though a small percentage worked in plants that primarily manufacture computers and office equipment.

Training, Other Qualifications, and Advancement

People interested in becoming semiconductor processors—either operators or technicians—need a solid background in mathematics and physical sciences. In addition to their application to the complex manufacturing processes performed in fabs, math and science knowledge are essentials for pursuing higher education in semiconductor technology—and knowledge of both subjects is one of the best ways to advance in the semiconductor fabricating field.

Semiconductor processor workers must also be able to think analytically and critically to anticipate problems and avoid costly mistakes. Communication skills also are vital, as workers must be able to convey their thoughts and ideas both orally and in writing.

Employers prefer to hire persons who have completed associate degree programs for semiconductor processor jobs. A high school diploma or equivalent is the minimum requirement for entry-level operator jobs in semiconductor fabrication plants. Although completion of a 1-year certificate program in semiconductor technology offered by some community colleges is an asset, technicians must have at least an associate degree in electronics technology or a related field.

Degree or certificate candidates who get hands-on training while attending school look even more attractive to prospective employers. Semiconductor technology programs in a growing number of community colleges include an internship at a semiconductor fabricating plant; many students in these programs already hold full- or part-time jobs in the industry and work toward degrees in semiconductor technology in their spare time to update their skills or qualify for promotion to technician jobs. In addition, to ensure that operators and technicians keep their skills current, most employers provide 40 hours of formal training annually. Some employers also provide financial assistance to employees who want to earn associate and bachelor’s degrees.

Summer and part-time employment provide another option for getting started in the field for those who live near a semiconductor

processing plant. Students often are hired to work during the summer, and some students are allowed to continue working part time during the school year. Students in summer and part-time semiconductor processor jobs learn what education they need to prosper in the field. They also gain valuable experience that may lead to full-time employment after graduation.

Some semiconductor processing technicians transfer to sales engineer jobs with suppliers of the machines that manufacture the semiconductors or become field support personnel.

Job Outlook

Between 2000 and 2010, employment of semiconductor processors is projected to increase faster than the average for all occupations. Besides the creation of new jobs, additional openings will result from the need to replace workers who leave the occupation. Growing demand for semiconductors and semiconductor processors will stem from the many existing and future applications for semiconductors in computers, appliances, machinery, vehicles, cell phones and other telecommunications devices, and other equipment. Job prospects should be best for people with postsecondary education in electronics or semiconductor technology.

The electronic components and accessories industry is projected to be one of the most rapidly growing manufacturing industries. Moreover, industry development of semiconductors made from better materials means that semiconductors will become even smaller, more powerful, and more durable. For example, the industry has begun producing a new generation of microchips, made with copper rather than aluminum wires, which will better conduct electricity. Also, technology to develop chips based on plastic, rather than on silicon, will make computers durable enough to be used in a variety of applications in which they could not easily have been used previously. These technological developments and new applications will lead to employment growth in the industry and more semiconductor processor jobs.

Earnings

Median hourly earnings of electronic semiconductor processors were \$12.23 in 2000. The middle 50 percent earned between \$10.02 and \$15.36 an hour. The lowest 10 percent earned less than \$8.85, and the top 10 percent earned more than \$19.10 an hour.

Technicians with an associate degree in electronics or semiconductor technology generally started at higher salaries than those with less education. Almost one fourth of all electronic semiconductor processors belong to a union, considerably higher than the rate for all occupations.

Related Occupations

Electronic semiconductor processors do production work that resembles the work of precision assemblers and fabricators of electrical and electronic equipment. Also, many electronic semiconductor processors have academic training in semiconductor technology, which emphasizes scientific and engineering principles. Other occupations that require some college or postsecondary vocational training emphasizing such principles are engineering technicians, electrical and electronics engineers, and science technicians.

Sources of Additional Information

For more information on semiconductor processor careers, contact:

- ▶ Semiconductor Industry Association, 181 Metro Dr., Suite 450, San Jose, CA 95110. Internet: <http://www.semichips.org>
- ▶ SEMATECH, 2706 Montopolis Dr., Austin, TX 78741. Internet: <http://www.4chipjobs.com>
- ▶ Maricopa Advanced Technology Education Center (MATEC), 2323 West 14th St., Suite 540, Tempe, AZ 85281. Internet: <http://matec.org>