Semiconductor Processors

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Significant Points

- Employment is expected to decline over the next 10 years because of rising imports of computer chips and increasing automation of fabrication plants in this country.
- An associate degree in a relevant curriculum is increasingly required.

Nature of the Work

Electronic semiconductors—also known as computer chips, microchips, or integrated circuits—are the miniature but powerful brains of high-technology equipment. Semiconductors are composed of a myriad of tiny aluminum or copper lines and electric switches, which manipulate the flow of electrical current. Semiconductor processors are responsible for many of the steps necessary in the manufacture of each semiconductor that goes into personal computers, missile guidance systems, and a host of other electronic equipment.

Semiconductor processors manufacture semiconductors in disks of varying sizes, generally eight to twelve inches wide. 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 or scores of individual chips.

Semiconductor processors make wafers by means of photolithography, a printing process for creating patterns 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 "cleanrooms"—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 cleanrooms—both operators and technicians—must wear special lightweight outer garments known as "bunny suits." These garments fit over clothing to prevent lint and other particles from contaminating semiconductor-processing worksites.

Operators, who make up the majority of the workers in cleanrooms, 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. Operators 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.

Once begun, the 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 cleanrooms, but they troubleshoot production problems and make equipment adjustments and repairs. They also take the lead in assuring quality control and in maintaining equipment. To keep equipment repairs to a minimum, 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 their production. Because the machinery sets operators' rate of work in the largely automated production process, workers maintain 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 cleanroom 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 a narrow range: usually, it is set at a comfortable 72 degrees Fahrenheit. Al-

Semiconductor processors increasingly need at least an associate degree.

though bunny suits cover virtually the entire body, except perhaps the eyes (over which workers wear protective glasses), their lightweight fabric keeps the temperature inside fairly comfortable as well. Entry and exit of workers in bunny suits from the cleanroom are controlled to minimize contamination, and workers must be reclothed in a clean suit and decontaminated each time they return to the cleanroom.

Several highly toxic chemicals are used at various points in the process of manufacturing semiconductors. Workers who are exposed to such chemicals can be harmed. However, semiconductor fabrication plants are designed with safeguards to ensure that these chemicals are handled, used, and disposed of without exposure to workers or the surrounding environment. Toxic chemicals are applied to wafers by computer-controlled machine tools in sealed chambers and there is normally little risk of workers coming into contact with them.

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 cleanroom operations brought about by changes in shift. In some plants, managers allow workers to alternate schedules, thereby distributing the "graveyard" shift equitably.

Employment

Electronic semiconductor processors held approximately 46,000 jobs in 2002. Nearly all of them were employed in facilities that manufacture semiconductors and other 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 the physical sciences. In addition to applying these disciplines 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.

A high school diploma or equivalent is the minimum requirement for entry-level operator jobs in semiconductor fabrication plants. However, employers increasingly prefer persons who have completed associate degree programs for semiconductor processor jobs. While completion of a 1-year certificate program in semiconductor technology offered by some community colleges is an asset for most processor jobs, 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, many 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 2002 and 2012, employment of semiconductor processors is projected to decline. The two main reasons for this reversal are much higher productivity and rising imports. Companies are upgrading many of their older fabs to make larger 12" wafers, which produce twice as many chips as fabs making 8" wafers. These plants also are more automated, allowing them to sharply increase production with the same number of workers. A number of domestic companies also are building more fabs overseas, where costs are lower. In addition, imports of semiconductors from non-U.S. companies are on the rise and should continue to increase throughout the decade. Besides the creation of new jobs, additional openings will result from the need to replace workers who leave the occupation.

Despite the expected decline in employment of semiconductor processors, the demand for semiconductor chips remains very high stemming from the many existing and future applications for semiconductors in computers, appliances, machinery, biotechnology, vehicles, cell phones and other telecommunications devices, and other equipment. Moreover, the advent of the new 64-bit microchip is expected to provide the power of computer servers or workstations, onto desktop computers and open up a wealth of new applications, particularly in medical devices.

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.

Job prospects will be best for people with postsecondary education in electronics or semiconductor technology.

Earnings

Median hourly earnings of electronic semiconductor processors were $13.14 in 2002. The middle 50 percent earned between $10.76 and $16.39 an hour. The lowest 10 percent earned less than $9.28, and the top 10 percent earned more than $20.35 an hour.

Technicians with an associate degree in electronics or semiconductor technology generally start at higher salaries than those with less education. Between a fourth and a half 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 oc-

cupations 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.sia-online.org**

➤ Maricopa Advanced Technology Education Center (MATEC), 2323 West 14th St., Suite 540, Tempe, AZ 85281. Internet: **http://matec.org/ops/career.shtml**