

---

# Semiconductor Processors

---

(O\*NET 51-9141.00)

---

## Significant Points

- Employment is expected to decline over the next 10 years because of increasing automation and the building of many new plants abroad.
- Opportunities will be best for applicants who have an associate degree in a relevant subject.

## Nature of the Work

Semiconductors are unique substances, which, under different conditions, can act as either conductors or insulators of electricity. Semiconductor processors turn one of these substances—silicon—into microchips, also known as integrated circuits. These microchips contain millions of tiny electronic components and are used in a wide range of products, from personal computers and cellular telephones to airplanes and missile guidance systems.

To manufacture microchips, *semiconductor processors* start with cylinders of silicon called ingots. First, the ingots are sliced into thin wafers. Using automated equipment, workers or robots polish the wafers, imprint precise microscopic patterns of the circuitry onto them using photolithography, etch out patterns with acids, and replace the patterns with conductors, such as aluminum or copper. The wafers then receive a chemical bath to make them smooth, and the imprint process begins again on a new layer with the next pattern. A complex chip may contain more than 20 layers of circuitry. Once the process is complete, wafers are then cut into individual chips, which are enclosed in a casing and shipped to equipment manufacturers.

The manufacturing and slicing of wafers to create semiconductors takes place in cleanrooms—production areas that are kept free of all airborne matter because the circuitry on a chip is so small that even microscopic particles can make it unusable. All semiconductor processors working in cleanrooms must wear special lightweight outer garments known as “bunny suits”. These garments fit over clothing to prevent lint and other particles from contaminating the cleanroom.

There are two types of semiconductor processors: operators and technicians. *Operators* start and monitor the equipment that performs the various production tasks. They spend the majority of their time at computer terminals, monitoring the operation of equipment to ensure that each of the tasks in the production of the wafer is performed correctly. Operators may also transfer wafer carriers from one station to the next, though the lifting of heavy wafer carriers is done by robots in most new fabricating plants.

*Technicians* are generally more experienced workers who troubleshoot production problems and make equipment adjustments and repairs. They take the lead in assuring quality control and in maintaining equipment. They also test completed chips to make sure they work properly. 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.

**Work environment.** 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 microchips during their production. Because the machinery sets the operators’ rate of work, workers maintain a relaxed 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 indicators.

The temperature in the cleanrooms must be kept within a narrow range and is generally comfortable for workers. Although bunny suits cover virtually the entire body, their lightweight fabric keeps the temperature inside fairly comfortable. Entry and exit of workers from the cleanroom are controlled to minimize contamination, and workers must be reclothed in a clean bunny suit and decontaminated each time they return to the cleanroom.

Several highly toxic chemicals are used at various points in the process of manufacturing microchips. Workers who are exposed to such chemicals can be seriously harmed. However, fabrication plants are designed with safeguards to ensure that these chemicals are handled, used, and disposed of without exposing 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. 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. Managers may also allow workers to alternate schedules, thereby distributing the overnight shift equitably.

## Training, Other Qualifications, and Advancement

People interested in becoming semiconductor processors—either operators or technicians—need strong technical skills, an ability to solve problems intuitively, and an ability to work in teams. Mathematics, including statistics, and physical science knowledge are also very useful. Communication skills and an



*Semiconductor processors wear protective garments called “bunny suits” to avoid contaminating the chips they produce.*

## Projections data from the National Employment Matrix

Occupational Title	SOC Code	Employment, 2006	Projected employment, 2016	Change, 2006-16	
				Number	Percent
Semiconductor processors .....	51-9141	42,000	37,000	-5,500	-13

NOTE: Data in this table are rounded. See the discussion of the employment projections table in the *Handbook* introductory chapter on *Occupational Information Included in the Handbook*.

understanding of manufacturing principles are also very important.

**Education and training.** For semiconductor processor jobs, employers prefer applicants who have completed an associate degree. However, experience plus completion of a 1-year certificate program in semiconductor technology, offered by some community colleges, may also be sufficient. Some semiconductor technology programs at community colleges include internships at semiconductor fabricating plants. Other applicants may qualify by completing a degree in high-tech manufacturing. Hands-on training is an important part of degree and certificate programs.

To ensure that operators and technicians keep their skills current, employers provide regular on-the-job training. Some employers also provide financial assistance to employees who want to earn an associate or bachelor's degree, especially if the employee is working toward becoming a technician.

**Advancement.** Workers advance as they become more comfortable with the equipment and better understand the manufacturing process. Employees train workers for several months, after which they become entry-level operators or technicians. After a few years, as they become more knowledgeable about the operations of the plant, they generally advance to the intermediate level. This entails greater responsibilities. Over time, usually 7 to 10 years, workers may become senior technicians, who lead teams of technicians and work directly with engineers to develop processes in the plant.

### Employment

Semiconductor processors held approximately 42,000 jobs in 2006. Nearly all of them were employed in the computer and electronic product manufacturing industry.

### Job Outlook

Employment of semiconductor processors is projected to decline through 2016. Opportunities will be best for those with a 2-year degree and experience working in high-tech manufacturing.

**Employment change.** Employment of semiconductor processors is projected to decline moderately, decreasing by 13 percent between 2006 and 2016. Although the demand for microchips is growing at a very rapid rate, employment levels in the industry will not increase over the next 10 years because of automation and the opening of fabricating plants in other countries. As the electrical components of chips become smaller, they become more sensitive. This means that chip manufacturers prefer precise robotics to human workers, who could potentially damage the chips. Additionally, there is a trend toward moving production to the areas where demand is most concentrated, thus, reducing the demand for U.S. exports of microchips. While this has not decreased U.S. production, fewer new plants are being constructed here.

Because of increased automation, most of the new positions created will be for technicians. While operator jobs will decline as older plants close and newer plants use more robotics, technician jobs will become more prevalent as the machinery becomes more complex and needs more monitoring. Technicians are responsible for understanding more of the fabrication process, so companies hiring new employees will expect a higher level of competency.

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 equipment.

**Job prospects.** Despite the decline in employment, some jobs will open up due to the need to replace workers who leave the occupation. Because specialized training is required to excel in this field, the number of openings is expected to remain in rough balance with the number of qualified job seekers. Prospects will be best for applicants with an associate degree and experience in high-tech manufacturing.

### Earnings

Median annual earnings of wage-and-salary semiconductor processors were \$32,860 in May 2006. The middle 50 percent earned between \$26,680 and \$40,620 an hour. The lowest 10 percent earned less than \$21,700, and the top 10 percent earned more than \$49,470 an hour.

Technicians with an associate degree in electronics or semiconductor technology generally start at higher salaries than those with less education.

Semiconductor processors generally received good benefits packages, including health care, disability plans and life insurance, stock options and retirement.

### Related Occupations

Semiconductor processors do production work that resembles the work of precision assemblers and fabricators of other high-tech 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 engineers, and science technicians.

### Sources of Additional Information

For more information on semiconductor processor careers, contact:

► Maricopa Advanced Technology Education Center, 2323 West 14th St., Suite 540, Tempe, AZ 85281.

Internet: <http://www.matec.org>

► Semiconductor Industry Association, 181 Metro Dr., Suite 450, San Jose, CA 95110. Internet: <http://www.sia-online.org>