

Background on Smart Sensors

Imagine a world in which. . .

a building senses earthquake vibrations and changes the stiffness of its walls to withstand the tremors.

cars drive themselves down the freeway, slowing down when the traffic ahead slows down, changing lanes to avoid obstacles, and using the roadway with optimum safety and efficiency.

robots not only detect but correct their own mechanical flaws.

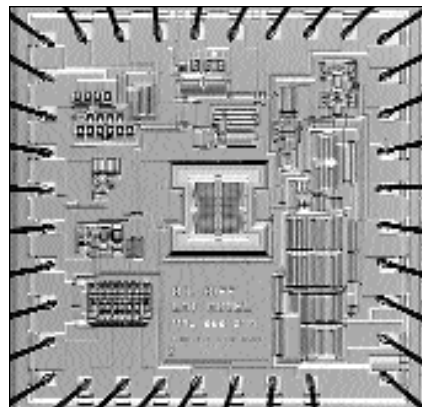
These might sound like ideas from a science-fiction movie script, but they're actually products of materials science research labs. They are examples of potential uses of new and sophisticated kinds of smart sensors—sensor systems that produce a specific response to a specific stimulus.

Overview of Smart Sensors

In Activity 3, students use piezoelectric PVDF film to construct a microphone, a simple smart sensor that combines a signal processing device with an amplifier that boosts the signal to an audible level. More sophisticated smart sensors go beyond converting a signal to a useful form. For instance, some have the ability to make a particular response to a change in temperature, pressure, or other environmental condition by applying some specific adjustment to the system. Others provide two-way communication by both sending and receiving signals. Still smarter sensors have self-diagnostic and self-calibrating capabilities—that is, they signal the system when they are in need

of maintenance or repair and adjust their calibrations to match changing conditions. An example is a computer equipped with a temperature sensor that reduces CPU clock speed (thereby slowing down the computer and lowering its operating temperature), turns on a cooling fan, sends a warning signal, or even shuts down the unit as temperatures reach hazardous levels.

The most sophisticated smart sensors are integrated with microprocessors that interpret signals



and communicate information in a digital display or other readable form. An example of a recent breakthrough in smart-sensor technology is micro-electro-mechanical systems (MEMS). MEMS are silicon semiconductor chips that incorporate sensors, information and signal processing, and control circuits in a single device. These sensors are used in complex systems, such as those that control antilock braking systems and airbag deployment in automobiles; regulate pressure, temperature, and humidity in HVAC (heating, ventilation, and air conditioning) systems; and monitor blood pressure, heart-beat, and breathing rate in hospital patients.

MEMS chips are used in complex HVAC, automobile, and medical systems.



Damage from a strong earthquake, such as the 1989 earthquake in San Francisco, may someday be lessened if buildings incorporate smart sensors.