CONTRIBUTED
MARKET REPORT

MARKET WATCH: Thin-Film Sensors

By Dr. Helia Jalili
Director of Advanced Materials, BCC Research

The global market and technology for thin-film sensors are expected to grow from $2.6 B in 2021 to $3 B in 2026 at a compound annual growth rate (CAGR) of 3.2% for 2022 2026.

The steady growth of thin-film sensors over the past 30 years can be attributed to miniaturization trends within the electronics industry, all thanks to the availability of advanced thin-film processes.

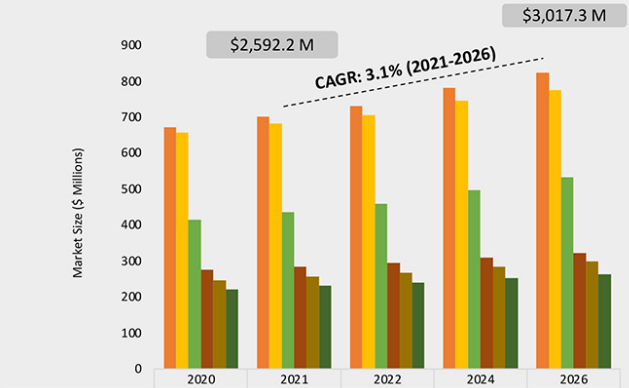
In our research, thin-film sensors are defined as sensors that comprise one or more layers thinner than 5 microns and manufactured with various technologies that involve vacuum, non-vacuum, or printing processes. There are different types of thin-film sensors such as pressure, temperature, humidity, gas, biochemical, and others.

COVID-19 has impacted the market for thin-film sensors, especially in industries such as healthcare and automotive. There was a surge in using sensor technology in remote sensing devices to monitor patient health conditions and patient self-care kits. In the automotive industry, there was a short-term decline due to the COVID-19 lockdown and shutdown of business operations. The adoption of thin-film sensors is not limited to healthcare, automotive, and the industrial sector. Most countries are implementing Industry 4.0 (which will be discussed in more detail later) and low carbon emission goals, which will further en-

MARKET WATCH: THIN-FILM SENSORS

Table 1 – Global Market and Technologies for Thin-Film Sensors, by Application, Through 2026 ($ Millions) *Source:* BCC Research

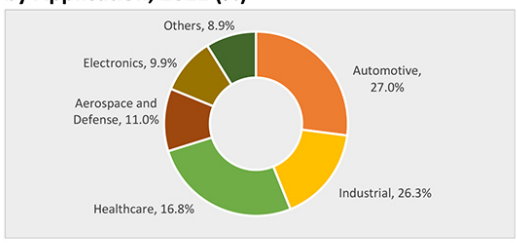
Global Market and Technologies For Thin-Film Sensors, by Application, Through 2026 ($ Millions)



	2020	2021	2022	2024	2026
Automotive	670.9	701.0	73010%	781.1	823.9
Industrial	657.3	682.2	705.7	745.1	775.5
Healthcare	414.4	436.4	457.9	497.6	533.6
Aerospace and Defense	275.0	285.0	294.4	309.9	321.7
Electronics	246.7	257.2	267.3	284.7	298.7
Others	221.5	230.5	239	253.1	263.9

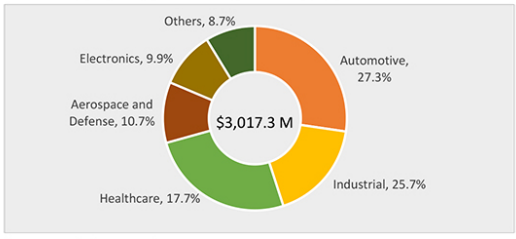
Source: BCC Research

Global Market and Technologies For Thin-Film Sensors, by Application, 2021 (%)



Source: BCC Research

Global Market and Technologies For Thin-Film Sensors, by Application, 2026 (%)



Source: BCC Research

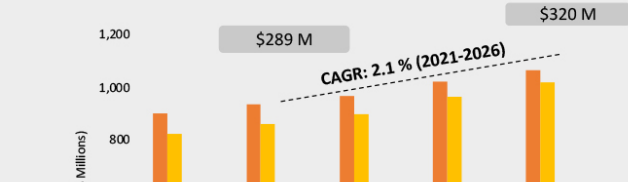
hance the adoption of thin-film sensors across the sectors and the globe. Other industrial applications are:

- Detecting harmful gases to maintain the safety of workers
- Maintaining the standard level of pressure and temperature in closed environment conditions
- Analyzing and monitoring various equipment and operations to enhance productivity.

The global market and technology for thin-film sensors are expected to grow from $2.6 B in 2021 to $3B in 2026 at a compound annual growth rate (CAGR) of 3.2% for 2021 2026.

Table 2 – Global Market For Thin-Film Sensors, by Type, Through 2026 ($ Millions) *Source:* BCC Research

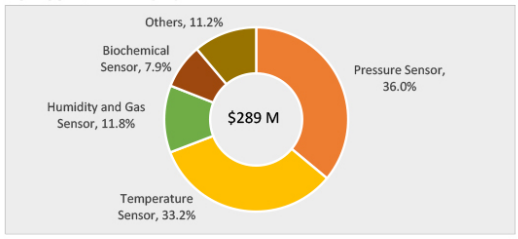
Global Market and Technologies For Thin-Film Sensors, by Type, Through 2026 ($ Millions)



	2020	2021	2022	2024	2026	CAGR (2021-2026)
Pressure Sensor	899.1	933.8	966.6	1,021.7	1,064.7	2.7%
Temperature Sensor	821.4	859.7	896.7	962.5	1,018.5	3.4%
Humidity and Gas Sensor	293.1	305.5	317.5	338.1	352.0	2.9%
Biochemical Sensor	191.5	204.1	216.3	239.8	262.0	5.1%
Others	280.7	289.1	297.3	309.5	320.1	2.1%

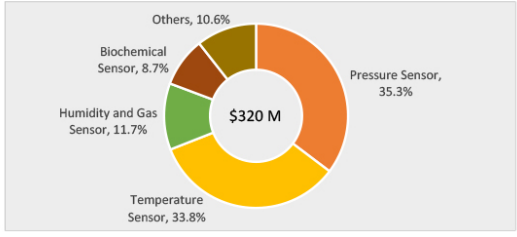
Note: Other type include Sleep sensor, pH sensors, position, movement and infrared, corrosion sensors, and level detection sensor.
Source: BCC Research

Global Market and Technologies For Thin-Film Sensors, by Type, 2021 (%)



Source: BCC Research

Global Market and Technologies For Thin-Film Sensors, by Type, 2026 (%)



Source: BCC Research

Note: Other types include sleep sensors, pH sensors, position, movement and infrared, corrosion sensors, and level detection sensors.

Table 3 – Gas Sensor Technology Application *Source:* BCC Research

Application	Harmful Gas	Major usage Area
Safety	hydrogen sulfide (H_2S), ammonia (NH_3), nitrogen dioxide (NO_2), oxygen (O_2) deficiency, carbon monoxide (CO), etc.	Leak detection, Fire detection, Boiler control, and Toxic/ explosive/flammable gas detections
Medicine	inorganic gases (such as NO, N_2O, and CO), VOCs (such as isoprene, acetone, pentane, ethane)	Disease detection and Breath analysis
Industrial production	methane, hydrogen sulfide (H_2S), chlorine, ammonia (NH_3), carbon dioxide (CO_2), oxygen (O_2)	Process control and Fermentation control
Automobiles	ammonia (NH_3), carbon dioxide (CO_2), nitrogen oxide (NO_x)	Gasoline vapor detection, Filter control, and Car ventilation control
Environmental control	NO_x, SO_x, HCl, CO_2, volatile organic compounds (VOCs)	Weather stations and Pollution monitoring

MARKET DRIVERS

Detection and prevention of hazardous pollutants

With increasing global climate change and constant warnings by environmental scientists, reducing global warming to 1.5 degrees Celsius over pre-industrial level and net-zero emission has become a crucial objective for the sustainability of the environment.

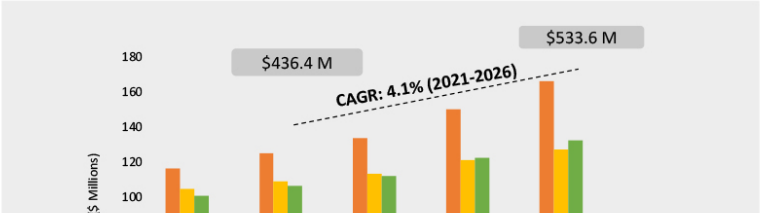
Monitoring and measuring the emission occurring from various industrial applications such as agriculture, landfill, biogas, heating, ventilation, and air conditioning (HVAC), are the key factors enabling the reduction of greenhouse gas emissions.

The incorporation of nanostructured material in gas sensing increases the applicability of these sensors to monitor and detect hazardous gases. Nanostructure helps design sensors in various shapes as per the application area, enhancing the ability to absorb defined gases. Nanomaterials gas sensors could be in the form of nanoribbons, nanorods, carbon nanotubes, diamonds, and others.

The lead zirconate titanate-based pyroelectric infrared sensor (PZT) is an example of a gas sensor. PZT is being used in detecting and monitoring methane gases. The pyroelectric sensor works by electromagnetic radiation detection at a specific wavelength and is found in gas analyzers, laser detectors, fire alarms, and others. This type of sensor transforms electromagnetic energy into an electrical signal. Other examples of gas sensors are listed in Table 3.

Table 4 – Global Market For Thin-Film Sensors in Healthcare, by Type, Through 2026 ($ Millions) *Source:* BCC Research

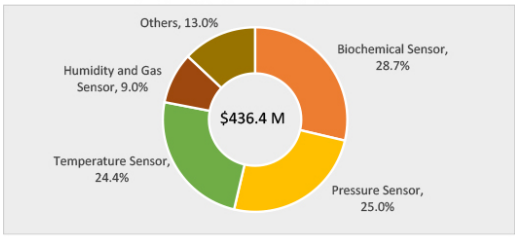
Global Market and Technologies For Thin-Film Sensors in Healthcare, by Type, Through 2026 ($ Millions)



	2020	2021	2022	2024	2026	CAGR (2021-2026)
Biochemical Sensor	116.5	125.1	133.5	150.0	166.2	5.9%
Pressure Sensor	104.6	109.1	113.4	120.9	127.0	3.1%
Temperature Sensor	100.6	106.3	112.0	122.6	132.3	4.5%
Humidity and Gas Sensor	37.5	39.2	40.8	43.7	45.8	3.2%
Others	55.1	56.7	58.2	60.4	62.3	1.9%

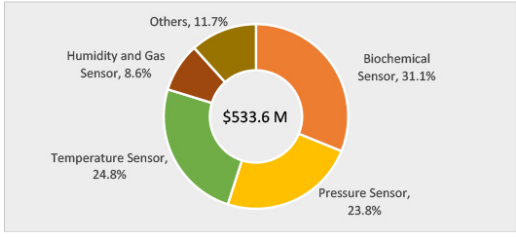
Note: Other type include Sleep sensor, pH sensors, position, movement and infrared, corrosion sensors, and level detection sensor.
Source: BCC Research

Global Market and Technologies For Thin-Film Sensors in Healthcare, by Type, 2021 (%)



Source: BCC Research

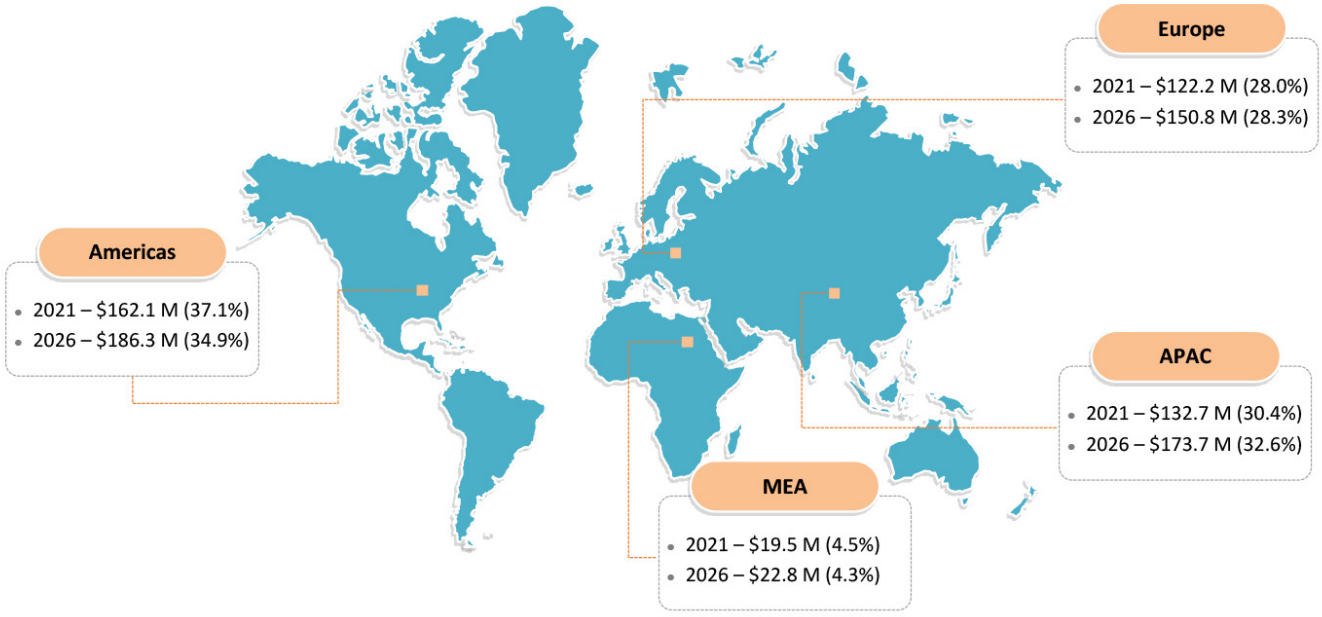
Global Market and Technologies For Thin-Film Sensors in Healthcare, by Type, 2026 (%)



Source: BCC Research

MARKET WATCH: THIN-FILM SENSORS

Table 5 – Global Market For Thin-Film Sensors in Healthcare, by Region, Through 2026 ($ Millions) *Source:* BCC Research

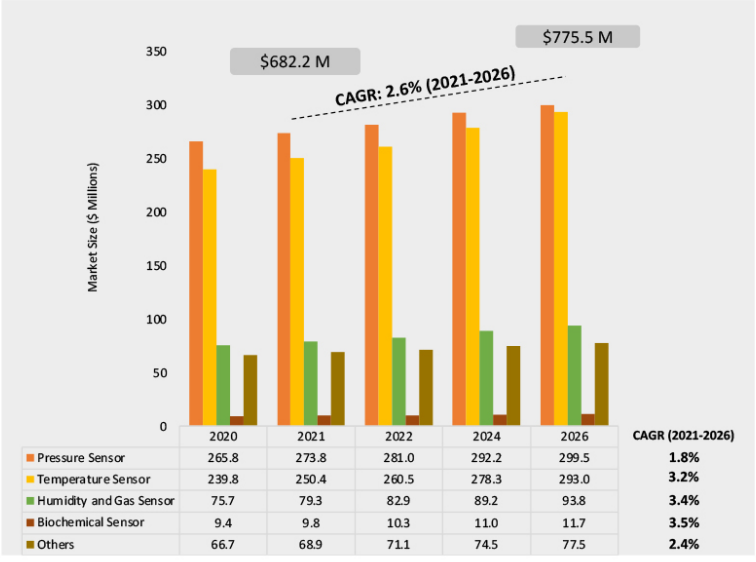


Increasing adoption in healthcare, Industrial 4.0, and IoT

In nanotechnology, the miniaturization of sensors plays a crucial role. The sensors have improved cost-effectiveness and productivity as chips have become miniaturized. This has also increased the functionality and accessibility of the technology. With their various features, such as improved electromechanical, magnetic, and photonic capabilities, size-affected nanoparticles become appropriate materials for sensing. Nanoparticles, for example, have been utilized as bio-tracers. Nanoparticles used for heightened sensitivity largely depend on their small size, with their qualities being heavily influenced by their high surface area.

Table 6 – Global Market For Thin-Film Sensors in Industrial, by Type, Through 2026 ($ Millions) *Source:* BCC Research

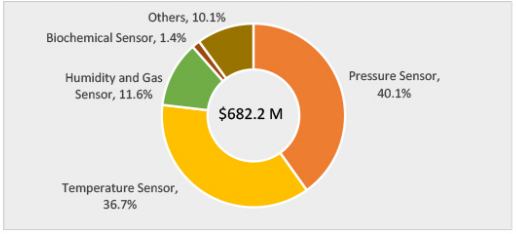
Global Market and Technologies For Thin-Film Sensors in Industrial, by Type, Through 2026 ($ Millions)



	2020	2021	2022	2024	2026	CAGR (2021-2026)
Pressure Sensor	265.8	273.8	281.0	292.2	299.5	1.8%
Temperature Sensor	239.8	250.4	260.5	278.3	293.0	3.2%
Humidity and Gas Sensor	75.7	79.3	82.9	89.2	93.8	3.4%
Biochemical Sensor	9.4	9.8	10.3	11.0	11.7	3.5%
Others	66.7	68.9	71.1	74.5	77.5	2.4%

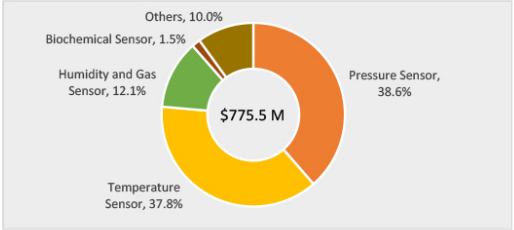
Source: BCC Research

Global Market and Technologies For Thin-Film Sensors in Industrial, by Type, 2021 (%)



Source: BCC Research

Global Market and Technologies For Thin-Film Sensors in Industrial, by Type, 2026 (%)



Source: BCC Research

Miniaturization based on thin-film technology in healthcare has led to the introduction of the microsystem in biosensors and healthcare sampling devices. Microneedles provide a painless and less- invasive option for epidermis penetration and access to the dermal interstitial fluid (ISF) to monitor various health parameters, compared to traditional painful blood extraction techniques. Thin-film biosensors help in blood glucose measurement as part of an electrochemical cell.

Multilayered thin-film-based biosensors get adhered to the skin and are used in conjunction with electronics to check the blood glucose level in any patient.

The global market for thin-film sensors used for healthcare applications is summarized in table 4. In 2020, the biochemical sensors had the largest market share at 116 million dollars. This market is estimated to reach $166 million dollars by 2026 at a growth rate of 5.9%.

Table 5 is a summary of the geographical distribution of market share for thin-film sensors in healthcare. In 2020, the US had the largest market share of approximately $154 million, whereas APAC had a $126 million market share. BCC forecasts a much higher growth rate for APAC in the next 5 years.

Industry 4.0 is changing the way businesses produce, enhance, and market their goods. Manufacturers incorporate enabling technologies such as cloud computing, the Internet of Things (IoT), artificial intelligence (AI), and analytics into their manufacturing facilities and processes. Enhanced sensors, embedded systems, and robots are used in this smart manufacturing to gather information and analyze the data, optimizing the manufacturing process.

Predictive maintenance, increased automation, self-optimization of improved efficiency, and, most importantly, a new level of responsiveness and efficiency to the consumer not before achievable are all benefits of this technology.

Various thin-film based miniature sensors are becoming part of embedded and IoT applications. The global market for thin-film sensors used for Industrial applications is listed in Table 6. In 2020, pressure sensors had a market share of $266 million, followed by temperature sensors at $240 million. With the recent advancement in technology and cost efficiency of temperature sensors, BCC forecasts a higher CAGR of 3.2% for temperature sensors.

Sensors can be embedded in nearly any environment, including personal use devices. These sensors will continue to grow smaller, more powerful, and more affordable. This means there may be as many as 1,000 sensors per person over the next ten years—more than one trillion sensors. The only limitation in this explosive growth, besides manufacturing capacity, is the need to support these sensors with sufficient computing power to make them IoT-capable.

BCC's sensor report and thin-film sensor report cover everything you need to know about the sensors market.

About the Editor: Helia Jalili

Dr. Helia Jalili is the Director of Advanced Materials at BCC Research. She received her Ph.D. in Material Physics and Nanotechnology from the University of Waterloo (Canada) and continued her research at MIT. She has over 15 years of R&D experience with functional materials for energy applications, spintronics, superconductivity, and additive manufacturing.

At BCC Research, she initiates and oversees over 200 market intelligence reports covering advanced materials (semiconductors, plastics, ceramics, metals), environment, sensors, information technology, and nanotechnology.