# Polymers and Textiles: You Are What You Wear

Polymers and textiles are an integral part of society. What we wear and what our clothing can do for us has helped define humanity for most of history. Clothing serves many purposes — fashion, protection from the elements, warmth, and identification. It is often an indicator of gender, social status, or religion, and is a powerful means of self-expression.

Today, technology in this sphere is rapidly evolving. How we manufacture polymers and textiles is changing for the better. As concerns over the impact of climate change increase, engineers and scientists working in polymers and textiles are focusing on developing more sustainable products.

At McGill Univ.'s Pulp and Paper Research Center in Quebec, Canada, chemists are using wood-based cellulose fibers to produce recylable, biodegradable textiles. Typically, producing rayon fibers requires the use of carbon disulfide, a toxic chemical that can cause acute and chronic poisoning. The McGill process avoids this volatile liquid and generates fibers similar in strength to rayon.

Perhaps the most promising area of growth in this industry is smart textiles. They range from wearable electronics that act as simple sensors to those that can sense, react, and adapt to changing environmental conditions. Advanced textiles have a multitude of applications, such as in gear that protects against fire, weather, and chemical/biological agents. Wearable sensors are particularly useful in healthcare, sports and fitness, and everyday use — these devices can track body temperature, heart rate, blood sugar, and more.

A recent report published by SBWire estimates that the global smart-textile industry will grow at a compound annual growth rate (CAGR) of nearly 25% by 2030. One major player in the market is Google, which recently partnered with Levi to develop a smart denim jacket that responds to touch gestures on its cuff. The garment can connect to a smartphone, and swiping and tapping the cuff issues commands such as answering a call or skipping a song.

AiQ Smart Clothing, a company based in Taiwan, specializes in clothing for athletes. Its garments can monitor heart rate and act as an electrocardiogram (EKG) through conductive, fiber-based electrodes.

Outside of everyday applications, smart textiles will likely serve an important purpose in more critical arenas, such as defense and space exploration. Engineers at the Massachusetts Institute of Technology (MIT) are expanding on a project begun by scientists at NASA and the U.S. Air Force in the late 1950s — the mechanical counterpressure suit, an experimental spacesuit that applies constant, stable pressure to the human body. Such an invention would be invaluable to astronauts during future surface exploration missions to the moon and Mars, allowing them to move more freely.

The MIT Biosuit uses tensioned fabric in direct contact with the skin to exert the necessary pressure. An elastomer as well as a shape memory polymer (SMP) composite are integral parts of their design. SMPs can be deformed and then rapidly return to their original shape in response to a trigger such as temperature change.

Current research efforts are aimed at developing a fully functional leg segment for the MIT Biosuit. Different fabrics, such as auxetic materials, are also under investigation. The MIT researchers hope to use these novel structures, which become thicker when stretched, to minimize the mechanical work needed to move.

Military scientists at the U.S. Army Combat Capabilities Development Command (CCDC) are using smart textiles and wearable technology to maximize soldiers' combat readiness. The addition of sensors, power storage, communications, and data processing is possible for almost anything a soldier might carry, including hard structures such as helmets or body armor, according to CCDC officials.

Researchers are also exploring the use of smart textiles for intelligence, surveillance, and reconnaissance purposes. Collected data may not directly impact the soldier, but information sent back to a command station could serve a tactical purpose. Beyond data collection, CCDC scientists are also looking to use health sensors in clothing to monitor soldiers' physical and mental health and allow officers to assess the operational readiness of their troops.

However, smart textiles are difficult to perfect. "Incorporating these types of technologies into clothing is an engineering challenge due to the nature of clothing," says Jeffrey Pacuska, the Technology and Systems Integration Lead at CCDC's Defense Fabric Discovery Center. "Products need to be manufacturable on a scale that the Army can buy them — current textile manufacturing is ill-suited to this task."

Indeed, smart textile technology has a long way to go; and Pacuska emphasizes the need for collaboration in bringing research to fruition.

"In order to accelerate the generation of these materials, we need to leverage the work being done in academia and in industry," he says. "It is our hope that with the Army as an early adopter of emerging wearable technologies, many dual-use applications may be found in the civilian/commercial sector, to help meet market needs and drive down costs."

AIChE will explore growth in polymers and textiles at its Polymers and Textiles Conference in Raleigh, NC, Oct. 7–8, 2020.

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