

Nanowear, Inc.
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Driving the evolution of health care wearables

Nanowear Inc. has developed next-generation nanosensors for applications in health care and beyond. Building on its first US Food and Drug Administration (FDA) 510(k) clearance for an undergarment that captures multi-channel electrocardiograms, Nanowear is now developing a garment to monitor congestive heart failure.

Since its founding in 2014, wearable technology company Nanowear Inc. has rapidly advanced textile-based nanosensor technology for applications in the health care diagnostics and chronic disease management markets. Invented by cofounder Vijay Varadan, Nanowear's proprietary nanosensor technology enables wireless, real-time electrophysiological, biometric, and biochemical monitoring for cost-effective, accurate, and continuous diagnosis through wearable garments that will boost patient compliance.

Nanowear's platform of noninvasive, cloth-based nanosensors opens new opportunities for health-care-associated applications and multiple other industry verticals seeking reliable, medical-grade, multichannel sensor technology to monitor the body continuously (Fig. 1).

According to Venk Varadan, Nanowear cofounder and CEO, "with very little advances happening over the past decades in skin-based sensors and how data are captured and transmitted, innovation in the space has been limited to digitizing and transmitting information captured using old sensor technology. Nanowear's nanosensor technology has now broken the cycle."

First-of-its-kind nanotechnology

Nanowear has patented technologies to manufacture and deposit nanosensors on fabric using nanocomposite inks that create nanostructures that exponentially increase the effective signal-capture area compared with that of a standard electrode or skin-based sensor. Nanowear's sensor technology is able to capture and aggregate millions of signals using the same surface area as a standard silver-silver chloride electrode, which results in reduced impedance and substantially higher signal-to-noise ratios. Signal capture and transmission by the Nanowear sensors are therefore unaffected by hair, moisture, soiling, or other factors that could compromise signal reliability.

Lead engineers Pratyush Rai and Mouli Ramasamy developed a process that allows the nanosensors to be deposited in any vector orientation or form factor on the body. The nanosensors capture the desired signals and transmit them to a centralized printed circuit board (PCB) via printed tracks consisting of a conductive fiber core and an insulation sheath made of nylon, polyester, or cotton; the finished product can be machine-washed without compromising signal fidelity. The PCB channels the data through a unique magnetic module, created by lead engineers Se Chang Oh and Prashanth Shyam Kumar, to Nanowear's mobile and web-based platform for algorithmic analysis. High signal-to-noise ratios and signal fidelity over time are the two critical parameters that distinguish Nanowear's nanosensors from other wearable sensors.

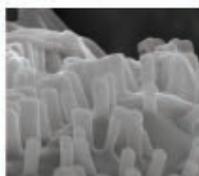


Figure 1: Nanowear's patented technology could become the *de facto* sensor for health care and many other industries.

Nanowear's sensor technology and fabrication process are supply-chain friendly and scalable without the need for heavy infrastructure or customized machinery. This makes the one-of-a-kind sensor technology affordable for many market applications.

Nanosensing heart failure

In December 2016, Nanowear received FDA 510(k) clearance for its first device, SimpleECG, a remote cardiac-monitoring undergarment that supplies multichannel electrocardiography (ECG), heart rate, and respiratory rate data from the garment to a physician-based web portal via the patient's iOS mobile app. The company is currently building on SimpleECG's product capabilities to create SimpleSense, a first-of-its-kind device for outpatient monitoring and alerts of congestive heart failure (CHF) and acute decompensated heart failure.

SimpleSense is a size-adjustable garment that simultaneously collects data on actigraphy, heart rate variability, respiratory rate, impedance cardiography, transthoracic impedance, and sound phonography ('S3' murmur detection). These metrics are continuously transmitted to Nanowear's platform, where a unique algorithm scores them and alerts physicians of a patient's worsening heart condition.

CHF ranks as one of the most important chronic diseases for hospitals and provider networks. The high rates of recurrence and readmission among CHF patients—and provisions such as penalties to health care providers in the US marketplace on a network's overall reimbursement if CHF patients show recidivism within 30 days—is pushing systems to seek and adopt novel technologies to minimize readmissions.

"As the world of health care continues to evolve, diagnostic and disease-management devices must both capture very accurate data and be easy for patients to use to ensure consistent data-feeding for algorithmic analysis and services," said John Zimmerman, Nanowear's CMO. "Affordable cloth-based wearables will be at the forefront of this evolution."

Nanowear's horizons

With the 'connected self' and the 'Internet of things' (IoT) now becoming the new normal, Nanowear's sensor technology is positioned well to drive the evolution of networks of data-gathering sensors and their integration into the world of cloud computing across many industries. Although Nanowear's end-to-end product focus is on CHF and SimpleSense, the company's nanosensors can be used in numerous IoT spaces. For example, what if we could capture medical-grade vitals every time a person unlocked his or her smartphone or tablet; ensure the safety of firefighters, police officers, and municipal and service workers by constantly monitoring them through their clothing; or continuously monitor how soldiers' bodies react under extreme conditions?

Nanowear is seeking strategic partnerships with medical device companies and provider networks to develop and commercialize SimpleSense, while also establishing a network of collaborators interested in licensing the core nanosensor technology as a sensor consumable for already-built products in the marketplace.

"While Nanowear believes that the immediate market opportunities are clearly in health care," said Venk Varadan, "we predict numerous applications for our nanosensors in consumer, industrial and safety, automotive, government, and military spaces; these industries are rapidly maturing, providing great potential for early movers."

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