Scalable Manufacturing for a Wearable, Integrated Human Performance Monitoring System

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Conformal, wearable and, in some cases, disposable microelectronic devices assembled on flexible substrates are revolutionizing the way technology integrates into our lives. These devices have the potential to enhance our security, make commerce more efficient, enable new capabilities in healthcare and potentially provide consumers the opportunity to integrate computing into their daily lives like never before. All this will be made possible by flexible electronic devices that can bend, roll, and in some cases fold into complex geometries. A key barrier to the realization of this paradigm is the ability to scale the manufacturing for integrated, highly functional devices and systems. At present many sensing and monitoring devices are produced via batch or sheet assembly processes more representative of semiconductor packaging, and as of yet do not represent the low-profile, low-cost "system-on-a-patch" concept that will ultimately enable a broader impact.

This project will establish a pathway to integration and manufacturing of a fully-capable wearable Human Performance Monitoring (HPM) sensor platform. In order to accomplish this, the focus will be a platform demonstrator of stand-alone value comprised of a versatile personal area sensor network, featuring pulse oximetry, pulse/heart rate and temperature measurement and capable of wireless reporting, to drive manufacturing innovation. The project leverages unique, complementary partner expertise, facilities, materials, and processes to develop engineered approaches that reduce or eliminate key manufacturing gaps and address technical challenges, with a particular emphasis on scalable R2R and print processes for system integration. The sensor system will include a thinned silicon microcontroller die with appropriate signal processing and wireless communication functions. Sensor and silicon electronics will assess a printed antenna sub-system with a printed conductive backplane for electrophoretic readout display for nonintrusive data visualization. The thinned silicon electronics sub-system will be integrated with the printed sensors and interface electronics. Integration challenges and manufacturing gaps will be assessed and resolved for printed electrocardiogram (ECG), skin temperature (resistive) and printed pulse-ox sensors. Platform optimization will further consider energy harvesting and storage, and wireless communications options for a fully integrated design.