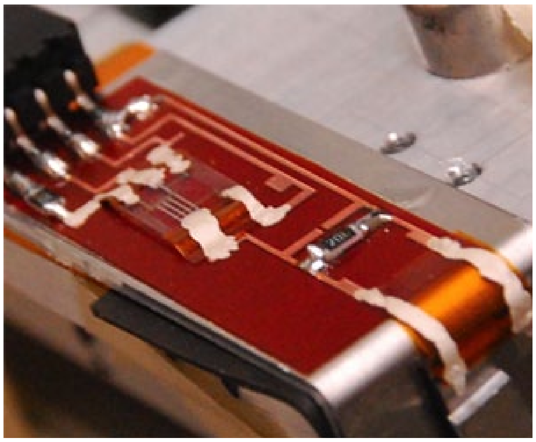
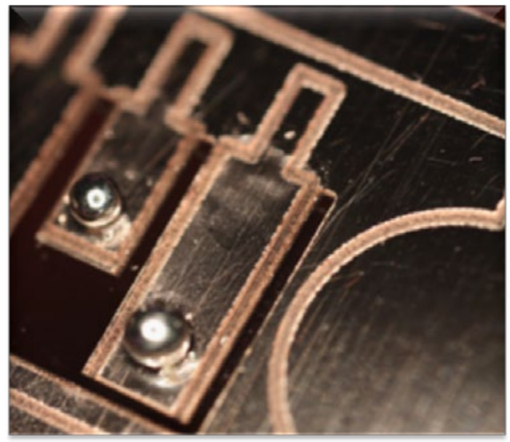
Case Study

parc
A Xerox Company

Meeting a High-Value, Custom Application Need Through Low-Cost, Novel Electronics





OVERVIEW:

Situation Analysis

Exposure to battlefield blasts over time can inflict head injuries on soldiers and emergency responders. To prevent traumatic brain injury, the U.S. government's Defense Advanced Research Projects Agency (DARPA) needed to develop an early detection technology that could monitor and record blasts *before* the cumulative exposure reached a harmful threshold. Specifically, they required a blast dosimeter that: (1) was robust enough to be deployed in the field for at least a week without requiring maintenance (i.e., no additional personnel); yet (2) was low-cost enough to be discarded after the data was analyzed and retained for medical records. No commercial alternative existed that met DARPA's needs.

PARC Solution

PARC scientists proposed a printed electronic "tape" that could sense, record, and read back the variety of data associated with battlefield explosions. Comprised of flexible, lightweight patches – which could conform to the curved shape of the protective helmets – the tape contained multiple piezoelectric sensors in different locations to record pressure, acceleration, acoustic levels, and light intensities. The tape also integrated the electronics needed to read out the sensor signals, including event trigger blocks, oscillator and amplifier circuits, shift registers, and non-volatile memory.

Process

In less than 2 years, PARC completed the project through a standard feasibility phase that involved meeting multiple milestones, weekly program manager meetings, and quarterly status meetings. PARC scientists had to deliver all the individual components (i.e., sensors and electronics) customized to DARPA's needs, while still achieving a target cost of $1. DARPA required the sensors to meet their specifications (see Table 1) within 10% tolerance. Since what was required was not available at the time, PARC developed novel thin-film transistor (TFT) processes with new materials, including both p- and n-type TFTs for printed complementary organic electronics to reduce power consumption. PARC also worked closely with printed electronics partners who developed new materials to address PARC and DARPA's performance requirements.

Pressure	Acoustic	Acceleration	Optical
5-100psi pressure pulse range	100-175dB acoustic range (measured up to ~500Hz)	5-1000g range	Linear response from 100-400klux
Reduced thermal cross sensitivity	Reduced thermal cross sensitivity	High-resonance frequency design	Maximum sensitivity between 350-500nm

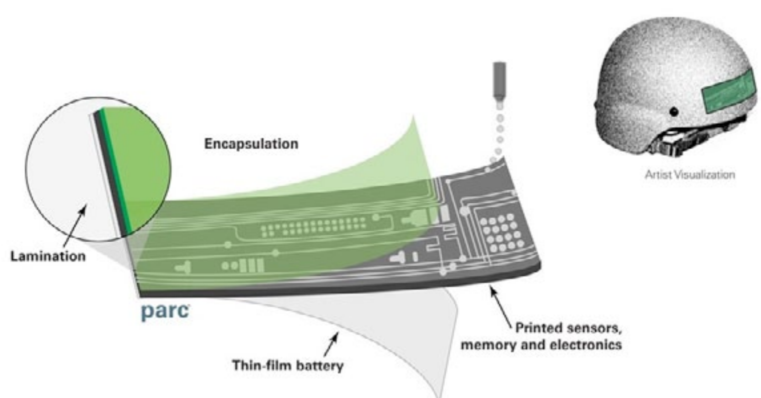
Table 1: Sensor specifications

Results

Enabled by deep expertise in printing, foundational materials, device design, and device testing, PARC scientists delivered the key components for a tape-like blast dosimeter with integrated memory, control electronics, and multiple sensors – all customized to DARPA's specific application needs. More importantly, the components could largely be fabricated through printing techniques or be compatible with roll-to-roll processing – key for enabling the novel form factors and low cost.

The resulting components not only met DARPA's requirement for disposability, but were robust enough to measure data at extreme levels. The PARC sensors achieved performance comparable to significantly more expensive commercially available sensors (less than $1 vs. $1000). It was also demonstrated that the memory array retained data for over a week.

Set up for flexibility and disposability, this expertise in printed electronics can now be adapted for device applications in patient health monitoring, packaging, structural monitoring, and other areas where flexible, low-cost sensors are required.



More Information

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