Over the last decade, significant effort has been directed towards the creation of printed electronics using conventional printing technologies. The use of printing technologies to create semiconductors and circuits has overcome some of the drawbacks and high production costs associated with conventional silicon technology. This includes the need for high-vacuum and high-temperature deposition processes, along with photolithographic patterning.

Presently, accelerometers are being used in football and other sports helmets to detect concussion-inducing head impacts. Such impact sensors do not conform to the curved surface of a helmet, making them a bulky addition to the helmet. Also, their method of impact measurement is inexact at best. These products only detect the magnitude and general direction of linear and rotational acceleration for the helmet.

**Technology Description**

Work in Dr. Atashbar’s laboratory has overcome many of the drawbacks of impact measurement with accelerometers by creating a screen printed, flexible impact sensor that fits inside a helmet and covers the entire interior surface of the helmet. This provides for exact measurement of the location and intensity of impacts to the skull.

To create the impact sensor, electrodes are printed on either side of a thin dielectric layer to form a capacitor. Multiple capacitors can be printed on a single flexible substrate that lines the inside of a helmet or another device, pinpointing impact locations (see Figure on next page). An impact causes a change in capacitance to a section of the flexible sensor. The change is measured by a flexible, printed analytical circuit and the data is wirelessly transmitted, in real-time, with instantaneous results provided in an easy-to-read format, to a computer, tablet or phone by means of Bluetooth, Wi-Fi, ZigBee, Cellular or RF. For convenience, a power supply can be placed anywhere on the wearer of the helmet or external to a device that is being monitored for impacts.

The sensor system has multiple applications beyond measurement of head impacts in sports and the military. The sensor and analytical/transmitting circuit can be printed into a wide range of shapes and sizes to conform to any application for aerospace, automotive, construction, sports and the military. Also, the impact sensor can be placed on the outside or inside of a device to detect impacts.

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Potential Benefits

- Uses traditional printing techniques, creating a thin, flexible sensor
- Analytical and transmitter circuits are printed to fit with the sensor as a single, flexible system
- Easily applied to a wide range of surfaces
- Accurate intensity and point of impact mapping
- Cost efficient manufacturing