GWAPO2—A Highly Conformable Multipurpose Wireless Autonomous Patch

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The CSEM Generic Wireless Autonomous Conformable Patch with Display (GWAPO) platform is a thin, miniature, flexible and rechargeable wireless interactive sensor system, i.e. an autonomous smart patch. It combines energy sources (e.g., PV/OPV), with pressure and temperature sensors, electronics, displays, interactive components, and antennas to create a highly comfortable multipurpose wireless autonomous patch.

To address wearable technologies such as activity trackers, hearing aids, virtual reality sensors, implementable sensors, CSEM has developed a generic, highly conformable, multipurpose, wireless patch with a display. This generic patch consists of an autonomous, flexible, and wearable platform with embedded sensors, electronics for computation, display, rechargeable battery, and renewable power source (photovoltaic), and wireless connectivity, including the antenna.

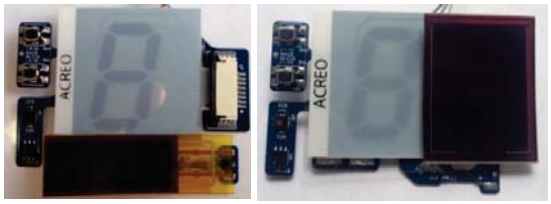

Figure 1: The generic flexible and wireless autonomous platform (left) and generic platform equipped with bigger PV cell for more autonomy.

For applications or sensors, such as a CO_2 sensor, where higher power is required, a second platform was designed to increase the harvested energy and to increase the charging speed of the battery (by a factor about two, Figure 1).

A comparison between the two GWAPO PV cells is provided by Figure 2. The results show the maximum available power (Pm) versus irradiance (Irr), up to 1 sun (i.e. 100 mW/cm^2).

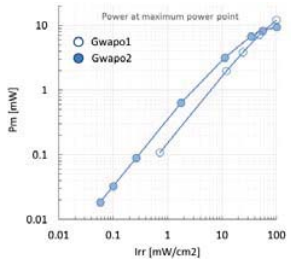

Figure 2: Power available at the maximum power point for the two thin-film silicon PV cells measured under various irradiances.

A first coating was applied to the patch in order to make it waterproof. This coating is extremely robust against tearing and bending and it is also bio-compatible.

Figure 3: Surrounding coating applied on the flexible patch.

Alternatively, a special, "conformable", ultra-thin, water-proof coating will be applied. This is done to increase the flexibility while enhancing the biocompatibility and user comfort.

GWAPO is a generic patch/platform. Almost any type of sensor (e.g., a pH sensor) can be connected to it. As such "wearable" patch solutions are important for medical applications (e.g., smart bandages), studies have been performed to investigate the performance of the sensor after the sterilization process (sodium hypochlorite). As shown in Figure 4, the sensors are not affected by the sterilization process.

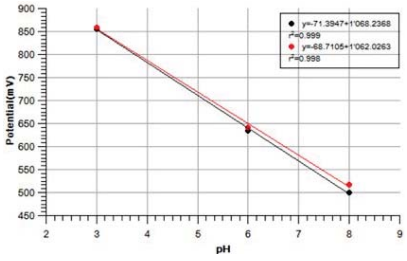

Figure 4: Calibration curve at 3 different pH before and after the sterilization.

Low-cost, printed sensors were developed for flexible, continuous and fully autonomous sensing applications. Figure 5 shows the developed pressure sensors made on PET-film with inkjet printed electrodes. The dynamic range of the sensors can be tuned with the composition of the structured-interlayer. A sensor response of more than 50 pF/mbar can be achieved.

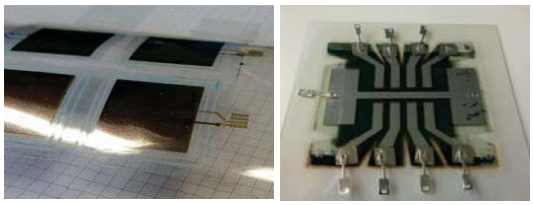

Figure 5: Printed, capacitive pressure sensors as a part of GWAPO platform in hybrid integration approach (left) and printed, flexible solar cells as a part of GWAPO platform in hybrid integration approach (right).

A foil-to-foil integration scheme was demonstrated in which OPV cells are integrated as standalone energy harvesting components onto the flexible PCB. The printed (blade coated), encapsulated cells (see Figure 5 right) achieved an efficiency of 4% under AM1.5 g illumination. The power output of the cells was in the range of 10-12 microwatts at 500 lux and 3-6 microwatts at 260 lux.

In a next phase, the OPV will be monolithically integrated by inkjet printing of the functional layers in the cell directly onto the flexible PCB. The inkjet-printability of the individual functional layers has been demonstrated. The next step is to inkjet-print all of the layers stacked on top of each other on the PCB in order to demonstrate a fully integrated, fully printed cell.