FLEXIBLE TAG MICROLAB DEVELOPMENT: GAS SENSORS INTEGRATION IN RFID FLEXIBLE TAGS FOR FOOD LOGISTIC

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Abstract: The technologies needed for the development of a flexible tag microlab will be presented. The realisation of the system includes physical and chemical gas sensors integration with RFID communication capabilities. Flexible substrate technologies used in the fabrication of the first prototypes of the RFID tag are shown together with the development of novel ultra low power hotplates for gas sensor integration.
Keywords: Flexible substrate technologies, gas sensors hotplates, RFID communication

INTRODUCTION

In the framework of the “GoodFood” FP6 Integrated Project (IP) [1], a Flexible Tag Microlab (FTM), integrating physical and chemical sensing and Radio Frequency IDentification (RFID) communication capabilities, for food monitoring during the logistic chain has being proposed (see Fig 1). This visionary application involves both the fabrication of the so-called inlay, which is the flexible substrate with all components needed for the FTM assembled on it, and the development of new ultra low power consumption substrates for gas sensor integration. Particular assembly and packaging issues for these critical components will be also be addressed.

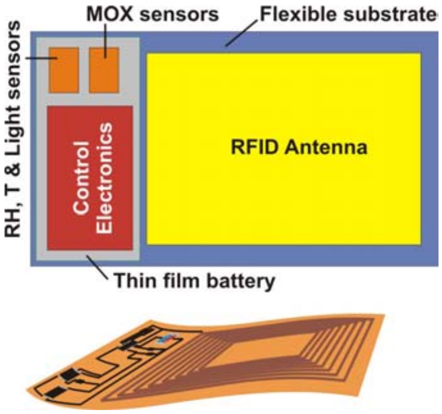

Figure 1. Main functional blocks of the FTM for food logistics..

RFID FLEXIBLE TAG

Flexible substrate (FS) and component assembly technologies for the FTM have been developed and/or optimised. A simple process outline for the FS fabrication is presented in Figure 2. The material employed is the DuPont™ Pyralux® AP 8525R double-sided, copper-clad laminate [2]. It is an adhesiveless laminate for flexible printed circuit applications. The Kapton has a thickness of 50 µm and the copper layer has a thickness of 18 µm on each side. In this procedure, the vias definition in Kapton is performed directly by femtosecond laser ablation. Then, the copper interconnections of the two metal levels necessary for the interconnect are generated by standard photolithography and wet etching. Finally, contacting through the vias was also implemented.

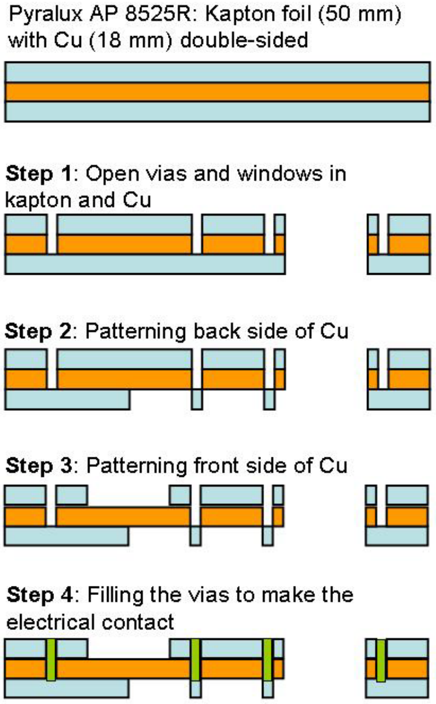

Figure 2. Process design for flexible substrates fabrication.

Figure 3 shows the first prototype fabricated including the electronic circuit interconnection with the assembled components (on the left) and the flexible antenna for RFID communication (on the right). The low power electronic is based on a Texas Instruments MSP430 microcontroller [3]. For this prototype packaged chips were integrated using conventional assembly technologies. However Anisotropic Conductive Adhesives (ACAs) flip chip technology is being implemented for the integration of bare dies in the next realisation.

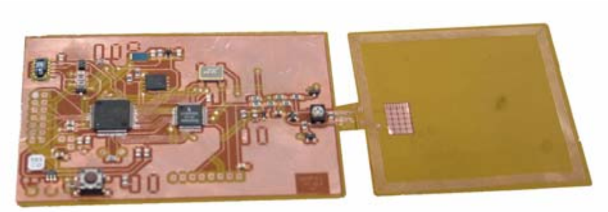

Figure 3. FTM first prototype including rH, temperature and light sensors and a flexible antenna

Regarding sensing capabilities, this prototype contain a Sensirion SHT 15 relative humidity and temperature sensor and a commercial light sensor, while ultra low power MOX sensor integration (see next section) will be incorporated in the next version.

ULTRA LOW POWER GAS SENSORS INTEGRATION

Ultra low power consumption hotplates for MOX sensor integration on FS have been developed. The hotplates were designed and optimized to fulfil the requirements of the RFID flexible tag application: ultra-low power consumption due to low energy availability, reduced die dimensions for tag flexibility and a die design compatible with reliable encapsulation on flexible substrates.

Front-side bulk micromachined suspended dielectric membranes were designed and fabricated, with a single Pt metallization layer implementing both the heating resistor and the sensing layer contacts on the same level. A circular hotplate layout was chosen in order to optimize temperature uniformity on the hot-spot of the suspended structure. Several devices were designed with different hotplate diameters ranging from 50 to 100 µm. With a 80 µm circular membrane, only 8 mW are necessary to reach 400 °C operating temperature.

Figure 4 shows a micrograph of a 1.5 x 1.0 mm^2 die implementing a 4-sensor array.

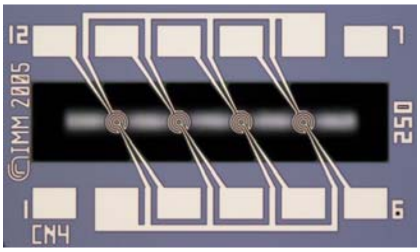

Figure 4. Ultra low power hotplates

The integration of MOX sensors hotplates requires specific assembling methods and protection of the chips from the environment. The integration involves the following main steps (see fig 5):

1) Windows opening by femtosecond laser ablation.
2) Patterning of the electrical contacts.
3) ACAs flip-chip for assembly.
4) Polymer casting and curing for encapsulation.

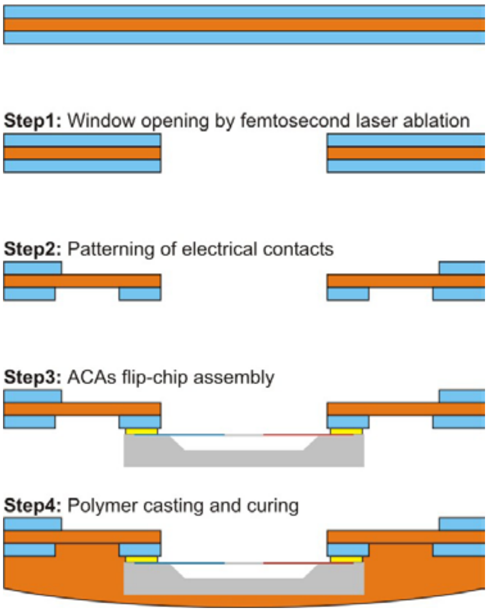

Figure 5. MOX sensor integration

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3. MSP430x1xx Family user's Guide, Texas Instruments (SLAU049E)