

SENSIMOX: towards a system-in-package multisensing smart cable

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Smart Cable Air (SCA) is a multi-sensor system-in-package (SiP) conceived and designed by Sensichips srl [1] in collaboration with UNIPI, based on the SENSIPLUS microchip which integrates a fully featured Electrochemical Impedance Spectrometer (EIS) with Temperature Controlled Operation (TCO) and several integrated sensors into a single 2x2mm chip with a low power consumption of maximum 1.5 mW. The SENSIPLUS chip features a multi-drop single wire serial bus interface conceived for distributed sensor arrays that can be configured into cables up to 100 meters long for large area monitoring, named as Smart Cables.

In the framework of the SENSIMOX project, arrays of two Ultra-Low-Power (ULP) Metal Oxide Semiconductor (MOX) sensors described previously [2] were optimized in terms of die size, pad layout and sensing layer composition, with the target of a SiP integration with the SensiPLUS ASIC and TCO operation for discriminative gas classification. A particular characteristic of the optimized SENSIMOX sensors is the nanostructured tin oxide (SnO₂) thin-film sensing layer, which is deposited at wafer level by means of a process described in [3]. This allows for the batch fabrication of over 3000 sensor arrays on a single 4" wafer, with high reproducibility at a low cost. The two independent sensors of the SENSIMOX die have the same SnO₂ sensing layer, but one of them features additional gold nanoclusters as catalyst.

SENSIPLUS is a microchip developed in a 0.18um mixed signal CMOS process and fabricated at the UMC semiconductor foundry in Taiwan. The chip was conceived ground up for orthogonal multi-sensors integration and data classification for improved analyte identification. It is based on the implementation at transistor level of precise analytics such as Electrochemical Impedance Spectroscopy (EIS) with a lock-in amplifier architecture and a Potentiostat/Galvanostat for continuous sensing applications, and a precise actuation stage that can be used for TCO of sensor hotplates. The chip also integrates sensors for Temperature, Relative Humidity, Ionic Vapors or particles and a photodiode, and supports connection of up to 16 external sensing elements.

The combination of SENSIPLUS with the SENSIMOX in a miniature SiP, complemented by the proprietary SENSIPLUS Learning Machine (SLM) algorithms, enables to build a miniature multisensory gas sensor with improved classification and identification capabilities.

[1] <https://sensichips.com/smart-cable-air/>

[2] I. Elmi et al., Sensors and Actuators: B. Chemical 135 (2008) 342-351

[3] I. Elmi et al., Sensors and Actuators: B. Chemical 131 (2008) 548-555

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