Rational design and development of room temperature hydrogen sensors compatible with CMOS technology: a necessary step for the coming renewable hydrogen economy

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The transition towards a new, renewable energy system based on green energy vectors, such as hydrogen, requires not only direct energy production and storage systems, but also the development of auxiliary components, such as highly sensitive hydrogen gas sensors integrated into mass devices that operate at ambient conditions [1]. Despite the recent advances in nanostructured metal oxide thin films in terms of simple fabrication processes and compatibility with integrated circuits [2], high sensitivity and short response/recovery times usually require the use of expensive noble metals or elevated temperatures (>250 ºC), which results in high power consumption and poor long-term stability. Within the Innovationscampus Elektronik und Mikrosensorik (iCampµs) Cottbus, our groups work on the development of a novel resistive hydrogen gas sensor based on thin and ultrathin films of CeO_2 [3], compatible with complementary metal oxide semiconductor (CMOS) technology, and capable of operating at room temperature. Their rational design implies a multidisciplinary bottom-up approach by which different work areas, such as sensor architecture, sensing mechanism and deposition strategy of the active layer, electrical contact design, depending on the desired electrical output, and fast testing under controlled environments, must be developed in parallel, constantly evolving by considering and integrating the progress achieved in the other project parts. This new sensor configuration, based on device miniaturization and supported by the use of thin films, means moving a step forward compared to previous thick layer and conglomerate sensor systems in terms of integration and materials deposition control.

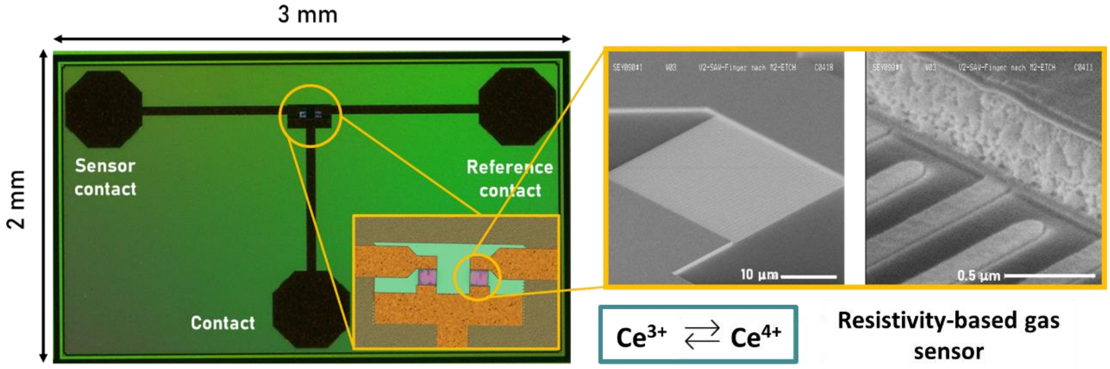

Figure 1. From left to right, optical image of the resistive CeO_2-based gas sensor and SEM zoom image into the metallic contacts coated with the sensing active material.

[1] Hübert, et al., *Sens. Actuators B Chem*. 2011, **157** (2), 329–352.

[2] Gu, H.; et al., *Sensors* 2012, **12** (5), 5517–5550

[3] Suzuki, et al., *Sens. Actuators B Chem*. 2017, **250**, 617–622 / Song, Y. et al., *Sens. Actuators B Chem.* 2023, **375**, 132957.