Solid state electrochemical sensor for the detection of hydrogen

F. Vivaldi[1]
A. Cerchiai[1], F. Di Francesco[1]
[1] *Department of Chemistry and Industrial Chemistry, University of Pisa, Via Giuseppe Moruzzi 13, Pisa, Italy*
Federico.vivaldi@unipi.it

The transition from fossil fuels to renewable energy is a major challenge in addressing climate change. As part of the European Green Deal, the EU aims to cut greenhouse gas emissions by 55% by 2030 and reach net zero by 2050. Hydrogen, as a clean energy carrier, plays a key role in sectors such as transport, industry, and energy. However, its use presents safety concerns due to properties like high flammability, wide explosive range, and rapid diffusion. Various hydrogen sensors (e.g. thermal, catalytic, electrochemical, optical, and mechanical) exist, but many suffer from limitations in operating conditions, such as restricted temperature or humidity ranges and cross-sensitivity.

To overcome these limitations, we developed a solid-state electrochemical hydrogen sensor that eliminates all liquid components to enhance robustness and operational stability. An image of the sensor, its calibration curve for hydrogen concentrations between 0.03–1.6% v/v, and its temperature sensitivity are shown in Figure 1A, B, and C, respectively. The data reveal a linear relationship between the sensor response and the logarithm of hydrogen concentration, consistent with the Nernst equation. Interestingly, the measured sensitivity exceeds the theoretical Nernstian slope of 59 mV/decade, indicating that additional mechanisms may be enhancing the response. Furthermore, the sensor maintains functionality at elevated temperatures, with no decline in performance, underscoring its robustness across a range of thermal conditions.

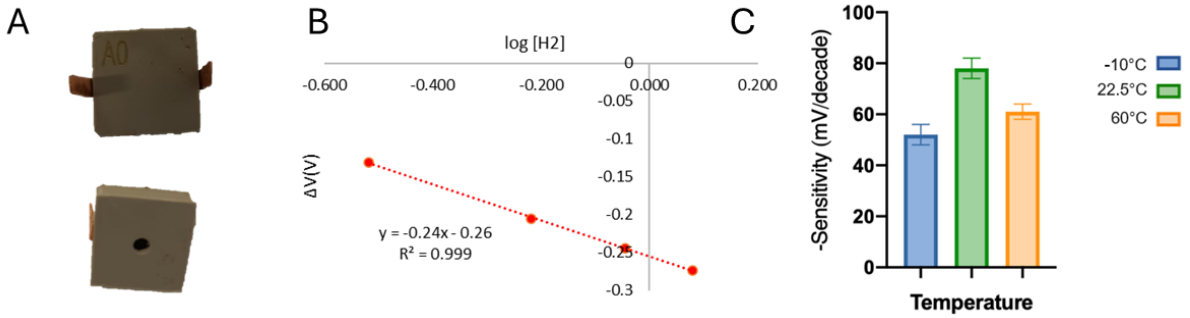

Figure 1: A) Picture of the solid-state hydrogen sensor. B) Typical calibration curve; the variation of the potential is shown as a function of the concentration of hydrogen. C) Sensitivity of the sensor as a function of the temperature in the range – 10 to 60 °C.

References

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[2] G. Korotcenkov, S. Do Han, J. R. Stetter, Chem. Rev. 2009, 109, 1402–1433.