SO_2 sensing mechanism of nanostructured SiC-SiOC core shell: an *operando* DRIFT investigation

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Previous works demonstrated the possible use of silicon carbide nanoparticles for the manufacturing of chemiresistive gas sensors with high selectivity towards sulphur dioxide (SO_2) [1]. The study presented here concerns an in-depth investigation of the sensing mechanisms of silicon carbide, focusing on the role that oxidation plays in the detection of SO_2. The research is split into two parts: the first part studies the oxidation of silicon carbide nanoparticles at different temperatures, while the second part measures the influence of sulphur dioxide on the sensor when is set at its optimal working conditions (650 °C), both in a dry and wet atmosphere. The sensors were characterised using a customised setup for *operando* diffuse reflectance infrared spectroscopy measurements (DRIFT), which allows evaluating the absorption spectrum of the sensing film that compose the sensor [2]. This work demonstrates that the silicon carbide nanoparticles start to oxidize, modifying the electrical behaviour of the sensors, both concerning the applied voltage and with respect to the working temperature. It is also proved that exposure to sulphur dioxide increases the oxidation rate of the silicon carbide film in working conditions, particularly in the presence of humidity. Finally, in analogy with the conduction mechanism observed on silica gel [3,4], it has been assumed that the electrical conduction is mainly ionic, with the working conditions that affects the concentration and the mobility of the charge carriers.

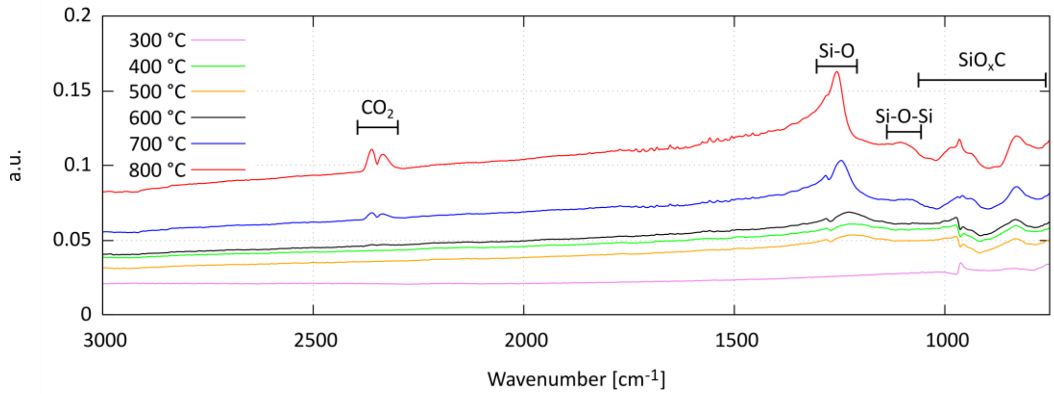

Fig. 1. DRIFT spectra on *SiC*-based chemiresistive gas sensors during *in-situ* oxidation at increasing temperature steps.

[1] A. Gaiardo, B. Fabbri, A. Giberti, M. Valt, S. Gherardi, V. Guidi, C. Malagù, P. Bellutti, G. Pepponi, D. Casotti, G. Cruciani, G. Zonta, N. Landini, M. Barozzi, S. Morandi, L. Vanzetti, R. Canteri, M. Della Ciana, A. Migliori, and E. Demenev. Sensors and Actuators B: Chemical, 305:127485 (2020).
[2] Matteo Valt, Michele Della Ciana, Barbara Fabbri, Diego Sali, Andrea Gaiardo, and Vincenzo Guidi. Sensors and Actuators B: Chemical, 341:130012 (2021).
[3] James Hunter Anderson and George A. Parks. The Journal of Physical Chemistry, 72(10):3662–3668, (1968).
[4] Masayuki Nogami, Ritsuko Nagao, and Cong Wong. The Journal of Physical Chemistry B, 102(30): 5772–5775 (1998).