Ozone analyzer for Air quality monitoring based in nanotechnology: A real industrial application

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The development of gas sensor devices with optimized selectivity and sensitivity has received much interest in recent years as they provide the ability to detect, for example, the presence of a non healthy gas concentration with low cost and low power energy. Furthermore, due to the rapid progress in micro and nanofabrication processes, some companies in this field have developed semiconductor oxide sensors in low range, i.e. sensors for air quality monitoring [1-3]. In order to reduce the cost, the best manufacturing process is the use of a semiconductor fabrication line. However, fundamental materials and processing issues, which are critical for a high-performance gas sensor, need to be assessed, as well as the influence of cross sensitivities with other gases or parameters. In particular, in this work we show the importance of the temperature in the ozone monitoring using this technique.

During the last two years, Ingenieros Asesores S.A has been developed an ozone analyzer for air quality monitoring, based on semiconductor oxide sensor (see fig. 1). The main part is the sensor, where a sensing layer, made of a metal oxide, generally SnO_2, is heated by a heater structure (see inset in fig. 1 (c)). When chemicals, in this case O_3, are absorbed on its surface, its electrical conductivity changes locally; this leads to a change of its electrical resistance. Analysing the modifications of the resistance over time, compared with reference values, information about variable gas concentrations is available. With the aim of registering the values of the resistance and to obtain the concentration ozone level conversion (Ohms to ppb) we have developed a micro data logger with mobile GSM communication and 12 V power supply which is possible to work with a small solar panel. In this way, the Ozone monitor has free mobility which makes it possible to install practically everywhere. The data of the analyzer are downloading using specifically developed software in a PC with a modem connexion.

The calibrated commercial sensor that we have used was first checked with good results in the laboratory (Temperature = 25ºC and Relative Humidity = 50%). For the conversion between electrical resistance and ozone level, the sensor applied a temperature correction at 25ºC following the equation: $R^{sensor}_{Tcorrection} = R^{sensor}_{original} * EXP\left[0.05 * \left(T_{offset} + T_{real} - 25\right)\right]$. This manufacturing temperature correction is good for laboratory conditions but what happens in a real case?

We have installed the system on the top of an air quality station in Toledo (Spain), to compare our results with the validated Ozone data on this place (UV absorbing Vs Semiconductor Gas sensor). We can see (fig. 2) the real importance of and extra temperature correction in the calculus of Ozone final value, with big differences with or without this new correction. We can clearly appreciate how the original temperature correction is only valid for temperatures lower than 25 ºC, not valid for a real monitoring case where temperatures can be higher. Other parameters as humidity or cross sensitivities with other gases are now under investigation.

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References:

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[2] W. Gopel, *Sensors and Actuators B*, **18-19** (1994), pp. 1-21.
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Figures:

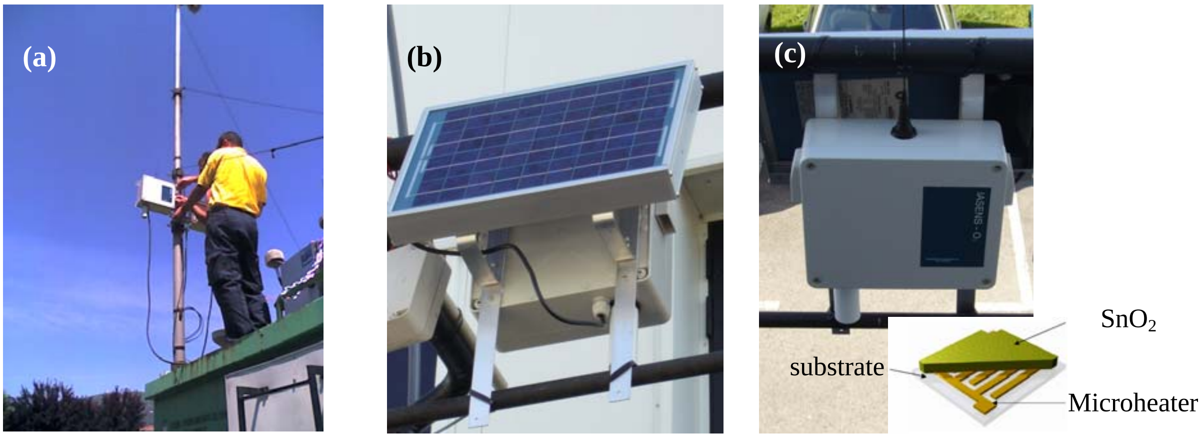

Fig. 1: (a) Ozone analyzer based on nanotechnology (IASens O_3) developed by Ingenieros Asesores S.A., being installed on the top of an air quality monitoring station. (b) and (c) back and front side respectively of an IASens O_3 system. We can see the Solar Panel for power supply and the antenna for GSM communications. Inset in (c), typical internal structure of the sensors.

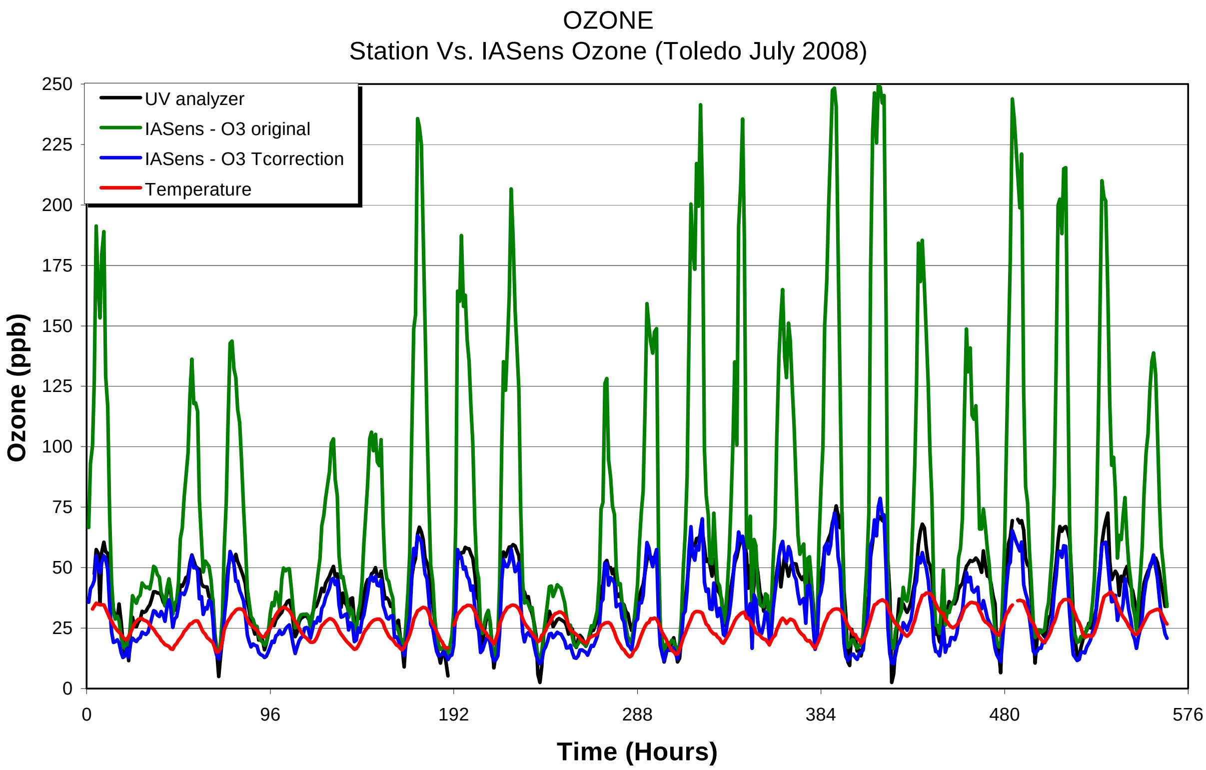

Fig. 2: Plot of the ozone concentration and temperature versus time in 24 days of July 2008. Ozone concentration measured by UV analyzer (black line); IASens original value with temperature correction at 25 ºC (green line); IASens corrected value depending of the temperature (blue line) and ambient temperature values in Toledo during this period (red line).