**Nafion Based Carbon Monoxide Sensors**

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Earlier we have reported on a Nafion-based amperometric carbon monoxide sensor that uses a 2-dimensional sensor architecture (1). The three electrodes are Teflon bonded platinum black, placed on a ceramic substrate with only the area over the sensing electrode been made porous. Nafion is solvent cast over an area that covers the electrodes and the sensor is completed with a water reservoir. The sensor architecture is very simple and the sensor shows rather good characteristics with detection limits in the sub-ppm levels and an excellent stability.

In this contribution the continuation of this work is reported. The original aim was to further improve the design so that the sensor could be used at sub-zero temperatures and the lifetime would not be limited by the amount of water. Further, each step of the manufacturing process was examined in order to make automated production possible. However, during the course of the work many problems were encountered, mostly related with solvent cast Nafion.

The sensitivity of a gas-sensor is a linear function of the triple point surface area; the area where gas, electrolyte and electrode come together. No reaction can take place on the catalyst if there is no electrolyte, also as CO has a limited solubility, only a thin layer of electrolyte can be penetrated by the gas, so the active area where the reaction takes place is much smaller than the total catalyst surface area. If there are no external influences, like diffusion limitations, a loss of sensitivity will be the result of a decrease of the triple point surface area. This can have several causes, like poisoning of the catalyst, slow flooding of the catalyst by liquid acid electrolyte and degradation of solid polymer electrolyte.

Several aspects were found to influence the sensor behavior. These include the Pt-current collectors, catalyst thickness, catalyst composition, Nafion thickness and Nafion quality. Depending upon the chosen configurations, sensitivities between 1 and 50 nA/ppm could be obtained and response times $t_{90}$ varying between 20 and over 300 seconds. The earlier observed excellent stability could be reproduced but only with the original materials. It was very disappointing to see that all other configurations showed declining sensitivities. After testing many sensor configurations and many sensors the most plausible explanation seems to be changes that occur in the Nafion layer. Additional problems were encountered when working with other batches of Nafion (the same product but another batch number).

In conclusion, applications where the Nafion is in ambient air or even when partially in contact with ambient air like the CO-sensor described above, are prone to having declining signals because of internal changes of the Nafion. Casting reproducible films from Nafion polymer solutions is far from evident. Small changes in the composition of the Nafion solution can have large effects on its casting properties like wetting and spreading of the polymer solution and the resulting thickness. Even inter-batch differences can cause devices to have dramatically different properties.

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REFERENCES

1 P.D. van der Wal, N.F. de Rooij, M. Koudelka-Hep; Analusis **27,** 347 (1999)