Characterization of a NASICON based potentiometric CO_2 sensor

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Abstract

In open devices, CO_2 sensors work in a differential mode and the response must only depend on the CO_2 pressure. To obtain a more stable response, the O_2 reference electrode consists of a material which can exchange oxygen with gas and sodium ions (Na^+) with the NASICON membrane. Such an electrode is composed of a mixture of sodium titanates $Na_2Ti_3O_7$-$Na_2Ti_6O_{13}$ and $La_{1-x}Sr_xMnO_3$ (LSM). This latter compound is added to improve the oxygen electrode reaction. The sensing electrode is composed of gold and a mixture of sodium and barium carbonates (Na_2CO_3 and $BaCO_3$). Different compositions of the two electrodes are investigated in a large range of CO_2 pressure. Sensors with a weight composition of carbonates about 3:1 in sodium and barium for the sensing electrode show a nernstian response in the 385-668°C temperature range. In this range, the experimental slopes are about 90% of the theoretical value. Below 385°C, a logarithmic function of the CO_2 pressure is still observed but deviations from the Nernst behaviour occur. A thermodynamic approach based on the standard potential E° point of view reveals a good agreement between theory and experiments.

Keywords: CO_2 sensors, sodium titanates, NASICON