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Thin film multi-junction thermocouple array for in-situ temperature monitoring of SOFC

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In-situ temperature monitoring from a working SOFC stack is very important for its health monitoring as well as for performance and degradation studies. The available methods in literature are not capable of measuring the temperature directly from electrodes, which is more desirable for investigating the cells’ behaviour and the correlation to the stack’s performance. Further, attaching multi-sensory points on the electrodes to measure temperature with a sufficient spatial resolution is a significant challenge and often can cause stack performance deterioration by disturbing the flow pattern. It has been developed and tested a cell integrated thin-film multi-junction thermocouple array that shares every merit of a conventional thermocouple. In addition, unlike the conventional thermocouples, which require two thermo-elements for each independent temperature measuring point, the multi-junction thermocouple array can measure temperature at $N^2$ number of points with only $2N$ number of thermo-elements, hence, far less number of external wires are required for temperature measurements at a number of points simultaneously. The performance of the multi-junction thermocouple array was computationally simulated and experimentally validated up to 1000°C from room temperature, which is the expected temperature range for SOFCs.

A thin-film multi-junction thermocouple array having 9 independent sensing points (hence, 6 thermo-elements) was sputter deposited on the cathode of a commercial SOFC (50mmx50mm, NextCell-5). Standard K-type thermocouple materials, Alumel (Ni 95%, Mn 2%, Al 2%, Si 1%) and Chromel (Ni 90%, Cr 10%) with 99.99% purity, were chosen for the thermo-elements. The cathode temperature distribution during anode reduction process and during normal cell operation were measured along with the Open Circuit Voltage (OCV) while having fixed a commercial thermocouple about 5mm adjacent to the cathode for a temperature comparison. The monitored cathode temperature via the in-situ sensors was directly correlated with the cell’s OCV whilst the commercial thermocouple showed a very dull change to them.