Degradation Behaviors of SOFC due to the Chemical Interaction between Trace Gaseous Impurities in Coal Syngas and Ni-YSZ Anode

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As one of the promising technology for efficient power generation from coal, the integrated gasification combined cycle (IGCC) has been developed so far in Japan.[1,2] In order to realize the efficient coal-based power generation with reduced carbon emission, new large-scale demonstration project on the oxygen-blown IGCC was launched in 2015 in Japan.[3] This project, Osaki CoolGen Project, aims to develop the advanced IGCC plant with carbon capture process to meet the greater efficiency and reduced carbon emission in the coal-based power generation. As an extension of such current R&D and demonstration about the IGCC, the incorporation of fuel-flexible SOFC (Solid Oxide Fuel Cell) into the coal gasification-based power plant could be considered, which is often called as the integrated gasification fuel cell combined cycle (IGFC). However, coal-derived syngas always contains trace chemical impurities such as S, Cl, volatilized metallic species etc. which would cause chemical degradation of SOFC anode material and performance loss.

We have conducted long-term power generation tests (400-1000hours) using electrolyte-support button-type single SOFC cell fueled by hydrogen and simulated coal syngas (mixtures of H₂ and CO) with trace level of H₂S and HCl to see if the performance of SOFC was affected by the trace impurities as well as fuel compositions. Trace level of HCl ranged from 1 to 10ppm in wet hydrogen did not interfere with electrochemical oxidation over the anode layer. Little performance loss was observed for the injection of wet hydrogen with trace H₂S less than 2ppm. However, we observed the apparent and irreversible performance loss in the case of injection of the simulated coal syngas (50vol%-CO and 20vol%-H₂) with H₂S less than 2ppm. Within the present experimental results, occurrence of the H₂S-induced performance loss was visible when the H₂S concentration exceeds to higher than 0.5ppm.

References