Strain Accumulation Study of Ni-based Anode-Supported Solid Oxide Fuel Cells under Partial-Redox Cycling Conditions

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Partial-redox cycles lead to severe degradation (electrolyte cracks) to Ni-based anode-supported solid oxide fuel cell (SOFC) when the cycle number is high (~10), even though the oxidation degree is below the critical level (~50%). Time controlled partial-redox cycles were implemented in SOFCs to investigate the effect of strain accumulation. It is found that this “partial-redox” cycle in which anode was oxidized partially (10%-40%) and then fully reduced, may bring irreversible cell expansion and mechanical damage, although it showed hardly any crack in the first few cycles. This phenomenon requires a more rigid re-oxidation level of restriction for those NASCs designed living through dozens or even hundreds of redox cycles. Strain accumulation effect was observed when the anode re-oxidation degree reached ca.20%, below which the cell was "safe". Both NiO and porosity gradient along anode thickness arise. SEM studies reveal that the redox front moves towards the electrolyte as redox cycle number increases, although the re-oxidation degree is constant. And the chemical reactions are considered the driving force for redox front move, which constantly bring irreversible strain to the anode.

Keywords: Solid oxide fuel cell; Partial-redox; Strain accumulation; Redox front; Chemical driving force

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