Multiscale-architectured thin-film LT-SOFCs with redox stability and fuel flexibility

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Abstract

Among the various known types of fuel cells, solid oxide fuel cells (SOFCs) are considered as a promising next-generation power source owing to their high power density and efficiency. However, the poor reliability of the SOFC at high temperatures is the biggest concern and intensive research has been pursued with the aim of lowering the operating temperature of SOFCs, because low-temperature SOFCs (LT-SOFCs), which can operate at temperatures ≤ 650 °C, can effectively suppress performance degradation. Therefore, in the field of SOFC research, thin-film technology has drawn much interest during the past decade ever since several groups reported remarkable potential to reduce the operating temperature without compensating the cell performance. It was expected that lowering the operating temperature would solve the most significant problem in SOFCs, i.e. fast degradation due to high operating temperatures, and in this aspect, low-temperature operating thin-film-base SOFCs (TF-SOFCs) were considered as a promising approach.

However, ironically, the stability of thin-film components at an elevated temperature, only several hundred °C, is disastrous, and the device stability often is not retained less than 1 hr. In this regard, our research team at KIST has tried to ensure both high performance at low temperatures and operational stability of thin-film components incorporated in the TF-SOFC. By implementing multiscale structures over sintered anode-support using thin-film technology, we have demonstrated remarkable performances reaching peak power density (PPD) of 0.5-0.6 W/cm2 at 500 °C and thermal cycle stability over 50 times. Now the PPD exceeding 0.7 W/cm2 and the cell stability less than 5 % degradation over 500 hrs at a constant current load at 500 °C have been achieved.

In spite of these significant progresses, there are still remaining issues, such as fuel flexibility and redox cycle stability in TF-SOFCs. The former is the most important advantage of the SOFC but it becomes more challenging at low temperatures. The latter is the most significant concern for the SOFC operation, especially for the portable and mobile applications which are targets of the TF-SOFC. During the past several years, we developed novel anode functional layers for coping with these issues, and results will be presented.

Keywords: *solid oxide fuel cell, thin films, low-temperature operation, stability, fuel flexibility*

Biography

Dr. Ji-Won Son is a principal researcher and head at the Center for Energy Materials Research, KIST. She received BS and MS degrees on Inorganic Materials at Seoul National University and Ph.D. at Dept. of Materials Science and Engineering, Stanford University. She has worked on implementation of thin film and nanostructure materials to lower the operating temperature of solid oxide fuel cells (SOFCs) by multiscale architecture.