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Innovations and technologies for direct conversion of natural gas in SOFCs: A novel Methane-fueled SOFC with molten metal anode

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Conventional coal-fired power plants have low efficiencies and emit large amount of carbon dioxide (CO_2), a greenhouse gas which causes climate change. Natural gas is a cleaner fuel and its combustion emits lesser CO_2 than coal; in addition, the recent boom in shale gas reserves and production with consequent drop in natural gas price has made natural gas a desirable fuel for power generation. A solid oxide fuel cell (SOFC) is an energy conversion device which can directly and efficiently convert the chemical energy in fuels to electricity with low emissions to the environment. Hydrogen is the fuel commonly used in fuel cells, but, in principle, the SOFC can operate on carbonaceous fuels, so a natural gas-fueled solid oxide fuel cell is an attractive technology which can efficiently generate electricity with low emissions compared to existing coal-fired power plants. However the direct electrochemical oxidation of methane in SOFCs is limited by carbon deposition, sintering and sulphur poisoning which result in deactivation of the nickel anode.

Recent innovations and technologies that directly use natural gas in SOFCs will be presented. More importantly, a novel SOFC with molten metal anode, which incorporates a molten metal bath and converts methane directly to electricity and other useful chemicals (e.g. hydrogen), will be presented; results on thermodynamic analysis, design and demonstration of this SOFC will be shown. This device obviates the problems of coking, sintering and poisoning of anodes which limit the performance of a methane-fueled SOFC.

Biography

Oluseye Agbede is a lecturer at the Department of Chemical Engineering, Ladoke Akintola University of Technology Ogbomoso, Nigeria. He did his PhD research at the Department of Chemical Engineering, Imperial College London, UK, under the supervision of Professors Klaus Hellgardt and Geoff Kelsall. He currently carries out research on the production of biofuels from microalgae and direct utilization of biofuels and fossil fuels in solid oxide fuel cells.