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Improvement of anode performance in a direct coal fuel cell

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In recent years, number of papers for a direct carbon fuel cell (DCFC) is rapidly growing every year. Probably, this reflects urgent needs for new power sources that can replace fossil-fuel power generation to some degree; more efficient, more environmental friendly, and more versatile method for power generation. A direct carbon fuel cell (DCFC) may be the closest candidate to meet the technological challenges because of its advantages: near 100% theoretical efficiency, no need for CO2 separation from exhaust lines, and possible use of any form of carbon containing solid fuels. However, it is also true that DCFC technology is yet far from the commercialization, mainly because of the difficulties in fuel and electrolyte configuration: non-continuous fuel supply and very limited formation of triple phase boundary. Here in this conference, we would like to present our novel ideas, how to resolve both of the difficulties, and the experiment results. The first idea is to maximize the triple phase boundary: using a porous fuel electrode filled with carbon powders and coating the electrode with ceria. We demonstrated this approach was quite successful, leading to 700% increase in a maximal power density and 500% increase in a maximal current density with respect to the standard case using a non-porous non-coated fuel electrode. This might be a solution for the limited electrical current generation owing to limited triple phase boundary. Then we turned out attention to resolve the other issue of how to resolve discontinuous fuel supply simultaneously. We will present some examples and demonstrate that the new conceptual design of the fuel electrode of DCFC works quite successfully so as to produce the power density up to the level of MCFC utilizing gaseous hydrogen fuel.