The effect of functionally graded carbon fuels in tubular DCFCs

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Since the direct electrochemical oxidation of solid carbon on the Ni-YSZ anode ($C + 2O^{2-} \rightarrow CO_2 + 4e^-$) is thought to be intrinsically sluggish and thus the main bottleneck in the development of DCFCs, various attempts have been devoted to not only promoting more effective contact between solid(fuels)-solid(catalysts) interface but also enhancing the catalytic activity of anode catalysts.

For this purpose, several types of additives are mixed with carbon fuels, and the fuels are functionally graded inside an anode-supported tubular solid oxide fuel cell for not only maximizing internal gasification effect but also minimizing detrimental effect due to carbon deposit on Ni anode catalyst. Impregnated Ni catalysts in primary fuels are expected to promote internal gasification by increasing the chemical oxidation of carbon to CO, which can be readily oxidized to CO_2 electrochemically on the Ni-YSZ anode. Furthermore, Sn or Sb in secondary fuels is expected to play an important role of retarding carbon deposit on Ni catalysts together with as an electrochemical mediator.

In this study, we report on the effect of functionally graded carbon fuels by taking advantage of tubular SOFC structure and typical characteristics of several additives.