

Supplementary Information

Effects of dispersed copper nanoparticles on Ni-ceria based dry methanol fuelled low temperature solid oxide fuel cells

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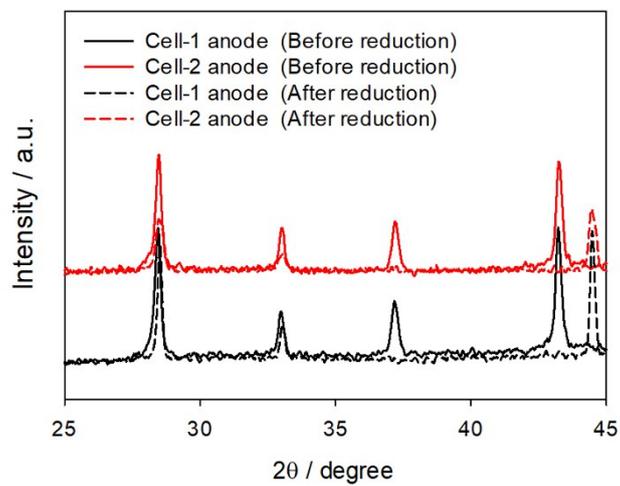
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Supplementary Figure 1. X-ray diffraction (XRD) patterns of Cell-1 and Cell-2 anode pellet before and after H₂ reduction at 700 °C for 1 h.



Supplementary Table 1. Grain sizes of GDC, NiO and Ni in Cell-1 and Cell-2 anode before and after H₂ reduction at 700 °C for 1 h. The grain sizes were calculated by the Scherrer's formula.

H ₂ reduction process	Anode pellet	GDC / nm	NiO / nm	Ni / nm
Before	Cell-1	50.54	37.24	-
	Cell-2	40.96	44.96	
After	Cell-1	51.53	-	58.76
	Cell-2	25.93	-	29.69

Supplementary Table 2. Area ratio of Ce³⁺ and Ce⁴⁺ in Cell-1 and Cell-2 from X-ray photoelectron spectroscopy (XPS) data.

Sample	Ce³⁺/Ce⁴⁺ ratio
Cell-1 anode	0.3445
Cell-2 anode	0.4623

Supplementary Table 3. Elemental quantitative data of the Cell-1 anode and Cell-2 anode after CH₃OH long-term test for 15 h and 60 h, respectively.

Element	Cell-1 anode / Atomic %	Cell-2 anode / Atomic %
C	82.22	35.62
O	7.01	31.29
Ni	7.85	16.97
Cu	0	3.01
Ce	2.62	11.84
Gd	0.30	1.27
Total	100.00	100.00