Electronic Supplementary Material (ESI) for Energy & Environmental Science

Supporting Online Materials for

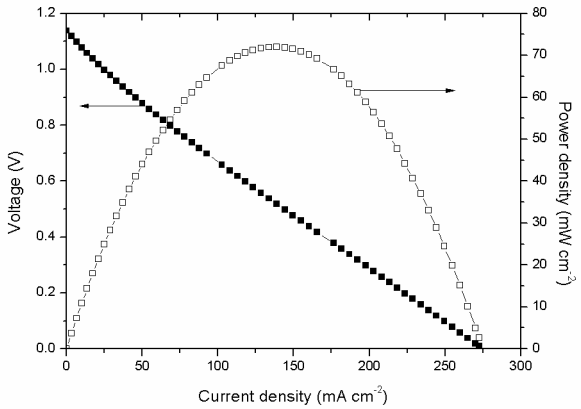
Demonstration of High Power, Direct Conversion of Waste-Derived Carbon in a Hybrid Direct Carbon Fuel Cell

Cairong Jiang[1], Jianjun Ma[1,2], Alfredo D. Bonaccorso[1] and John T. S. Irvine[1]*

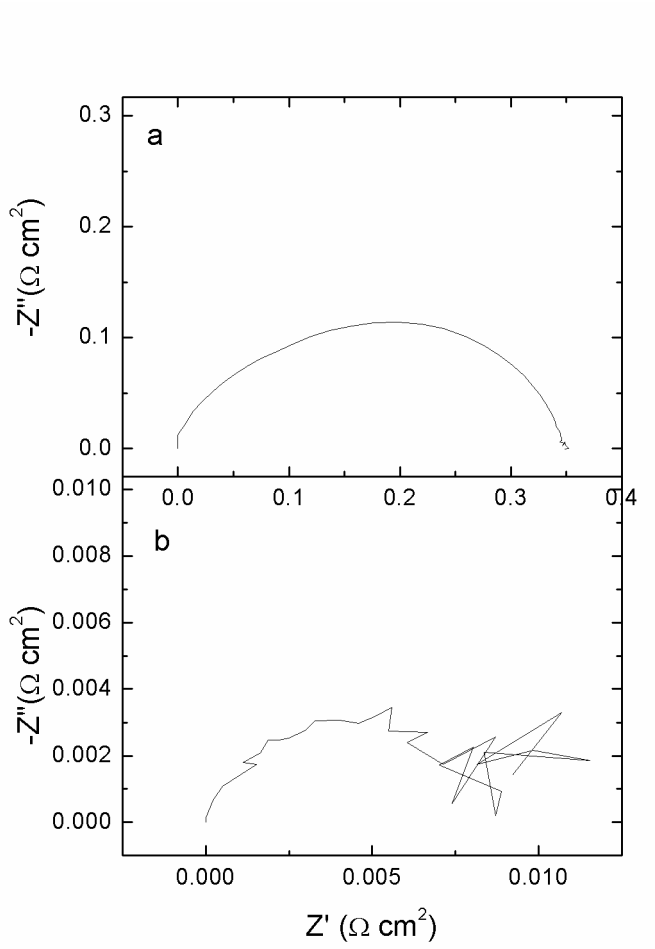
1 EaStCHEM, School of Chemistry, University of St Andrews, KY16 9ST, United Kingdom

2 School of Materials Science and Engineering, Chonnam National University, Gwangju 500-757, Republic of Korea

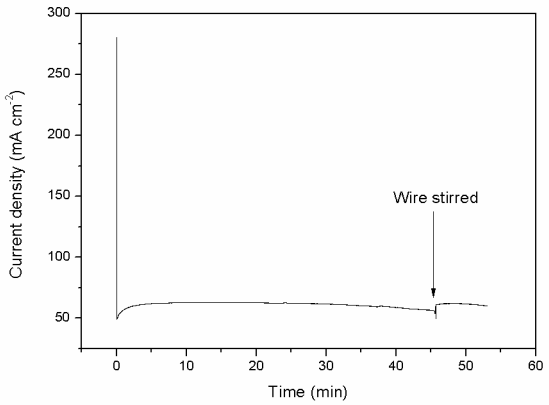
**To whom correspondence should be addressed to: jtsi@st-andrews.ac.uk*



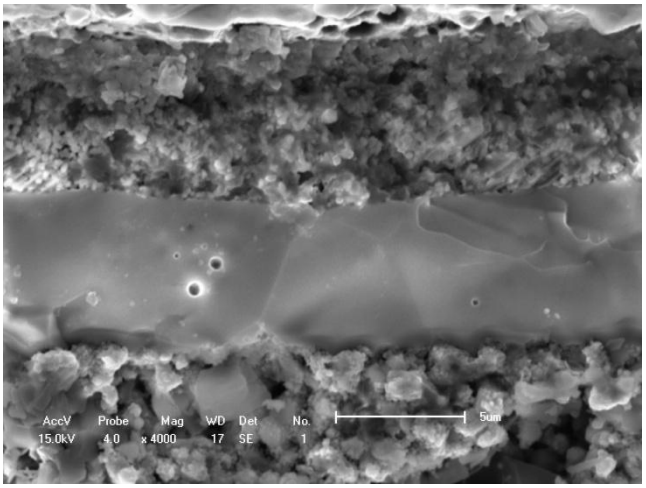
Supplementary Fig. S1 Hybrid direct carbon fuel cell performance and current-voltage characteristics of the cell with a 1 mm thick yttria-stabilized zirconia electrolyte, a NiO/YSZ composite anode and a LSM/YSZ composite cathode by screen printing, pyrolysed medium density fiberboard (PMDF) as the fuel, flow rate of N_2 purge gas is 20 ml/min, tested at 750 °C.



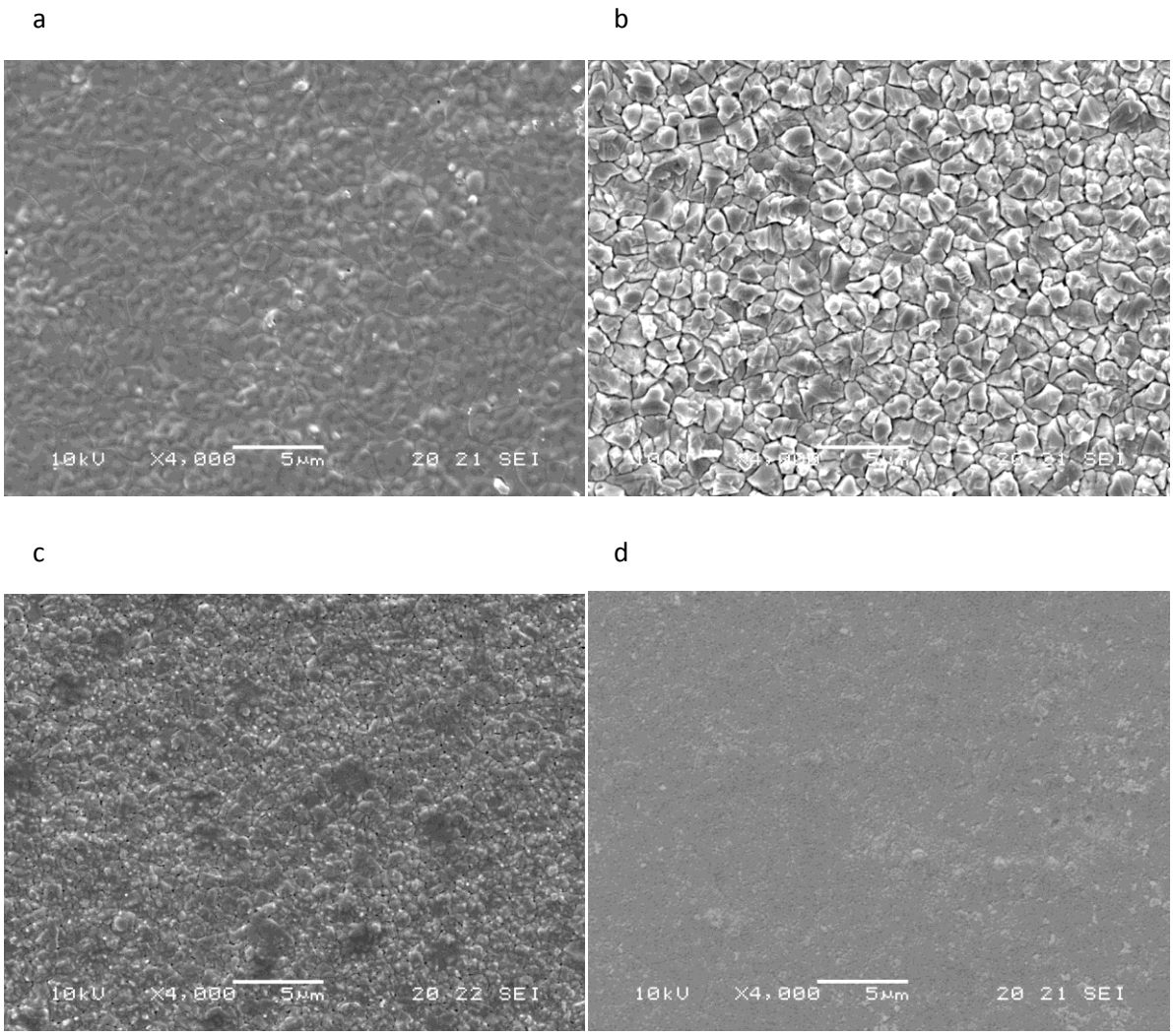
Supplementary Fig. S2 AC impedance spectra of the symmetric cells with a composite electrode of $(La_{0.8}Sr_{0.2})_{0.95}MnO_3$ and YSZ (50:50 weight ratio) on a YSZ pellet (a); $La_{0.6}Sr_{0.4}CoO_3$ electrode on a $Ce_{0.9}Gd_{0.1}O_2$ pellet (b). Note: the ohmic resistance was subtracted.



Supplementary Fig. S3 Short term stability of the hybrid direct carbon fuel cell with a 1 mm thick YSZ electrolyte, a screen printed NiO/YSZ (60:40 by weight ratio) anode and a LSM/YSZ cathode in a weight of 50 to 50. The open circuit voltage was 1.10 V and applied voltage was 700 mV. Stirring the current collection wire during the test prevented degrading, which might be from the carbon consumption around the current collection.



Supplementary Fig. S4 Cross section of the cell with a composite cathode of LSM-YSZ composite cathode, a YSZ electrolyte and a nickel cermet anode after electrochemical measurement. This cell has been operated for 2.5 hours at 500 mV with current density ranging from 384 to 160 mA cm^{-2}. The gas flow rate was 20 ml min^{-1} CO_2.



Supplementary Fig. S5 Surface microstructures of 8 mol% yttrium stabilised zirconia pellets. a, before corrosion test; b, etched in lithium-potassium carbonate in air at 700 °C for 10 hrs; c, etched in lithium-potassium carbonate in argon at 700 °C for 10 hrs; d, etched in lithium-potassium carbonate in 5%H_2/Ar at 700 °C for 10 hrs.