# Ionic Conducting Properties and Fuel Cell Performance Developed by Band Structures

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## Supporting Information:

Figure S1: The EDS elemental mapping of LMCO-SDC composite material reveal the uniform distribution of Co, Mg, Ce, Sm and O was shown in (g-k) and (l) also gives the EDS spectrum of LMCO-SDC, it is consistent with the result of mapping study. Here Lithium cannot be identified under an EDS because the X-ray florescence yield is extremely low for Li.

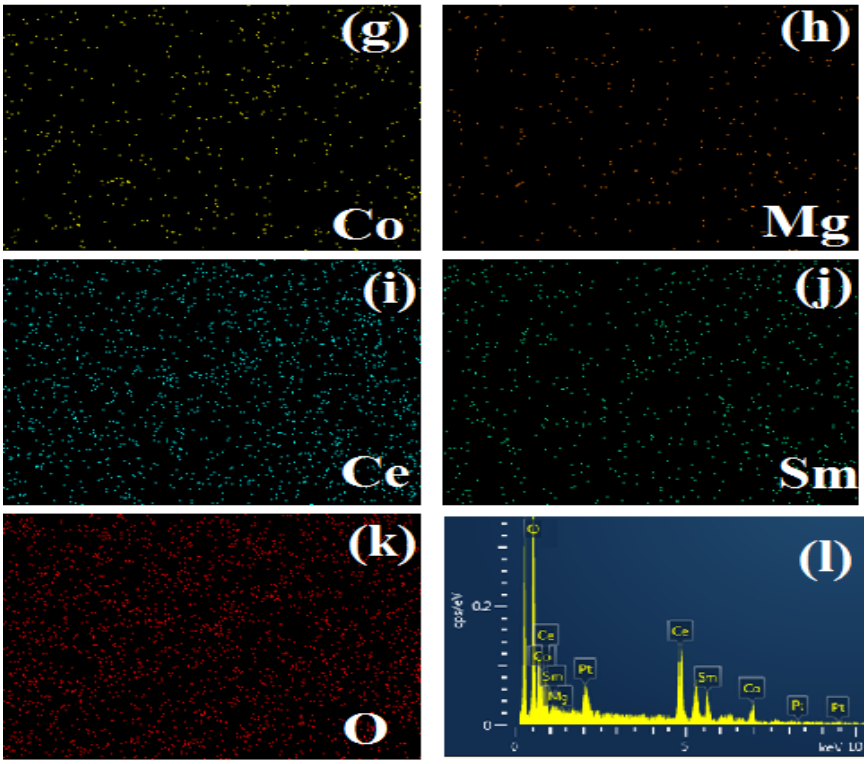


Figure S1 The EDS elemental mapping of LMCO-SDC composite material

Figure S2: XPS measurements were carried out at a constant pass energy of 20 eV for survey scans. The survey spectrum of composite fuel cells exhibited characteristic photo electron emissions at binding energies corresponds to Li, Mg, Co, Ce, Sm, C and O elements, the observed binding energy (BE) at 284.6 eV of C 1s is using for the reference in the present measurements.

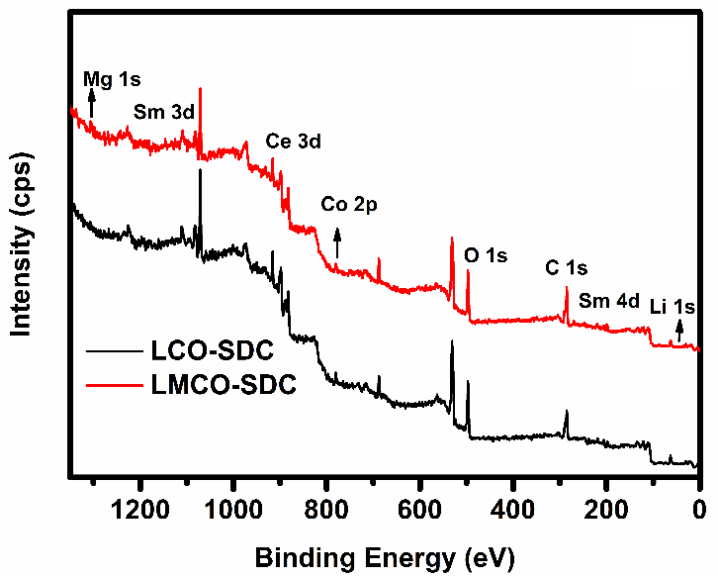


Figure S2 XPS results obtained for both LCO-SDC and LMCO-SDC

Figure S3: To identify the SDC effect on the LCO-SDC and LMCO-SDC we further investigated the SDC electrolyte fuel cell device. Fig. S3 depicts I-V and I-P characteristics of the Ni-NCAL/SDC/Ni-NCAL cell at 600 °C by using hydrogen as fuel and ambient air as oxidant. The peak power density 0.43 W/cm$^2$ and open circuit voltage is 1.01 V, respectively. While for SDC mixed with LCO and LMCO semiconductors reveals the corresponding values are 0.5 and 0.7 W/cm$^2$ and 0.89 and 1.02 V, respectively. The results clearly indicate the semiconductor materials LCO and LMCO do play a significant role in improvement of the ionic SDC electrolyte membrane fuel cell. We conclude that, well balanced ionic and electronic phases are play a vital role for achieving best performance.

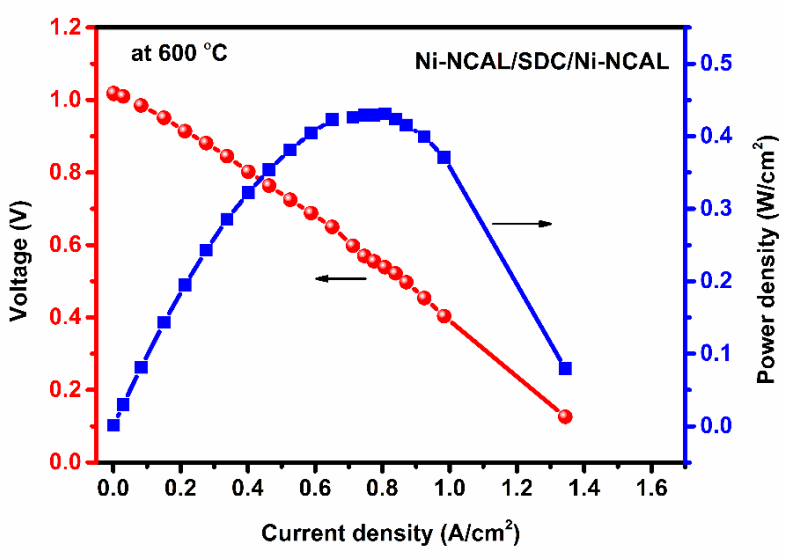


Figure S3 I-V and I-P characteristics of the Ni-NCAL/SDC/Ni-NCAL cell at 600 °C

Figure S4: The optical band gap energy ($E_g$) of the LCO and LMCO samples were determined by UV-vis and calculated at room temperature in the wavelength range 300 to 2500 nm by the data of the reflectance versus wavelength. The reflectance spectra demonstrates that the LCO exhibit the strong reflectance than LMCO, it indicates that LCO has higher $E_g$ than that of LMCO. It causes LCO has demonstrated low fuel cell performance.

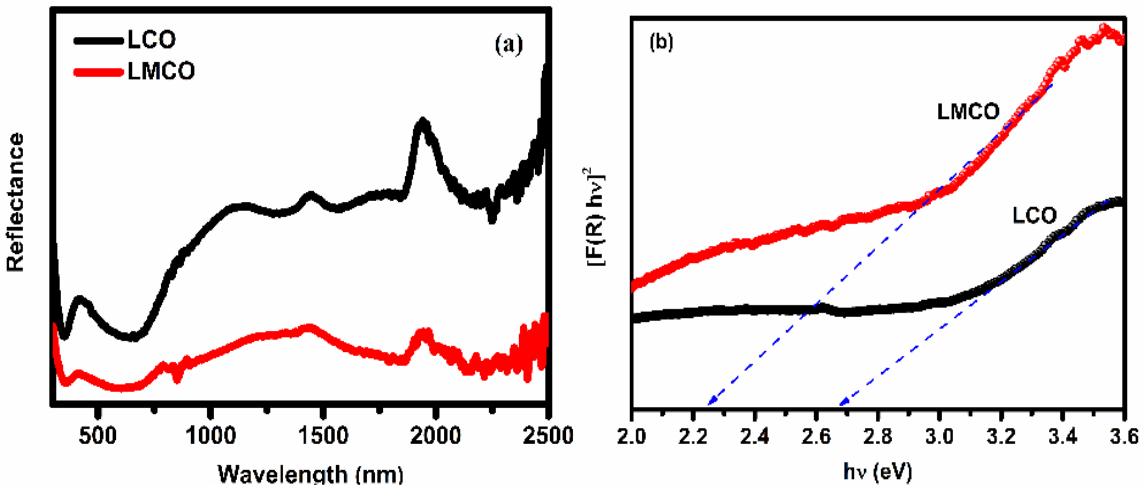


Figure S4 The UV-vis spectra (a) and (b) diffused reflectance spectra of LCO and LMCO