Semiconductor and heterostructure materials function for both electrolyte and electroctalyst in novel fuel cells

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Over hundred years, scientists have designed and searched for ionic conductivity by ionic conducting materials, but challenge unsolved. Typically, solid oxide fuel cell (SOFC), yttrium stabilized zirconia (YSZ) electrolyte, which needs high operational temperature above 700 °C to reach required ionic conductivity, for SOFC technology over several decades, not yet commercially. The YSZ can be now replaced by semiconductor or its heterostructure with higher ionic conductivity. Thus better fuel cell performances have been demonstrated bellow 600°C as shown in Figure 1.

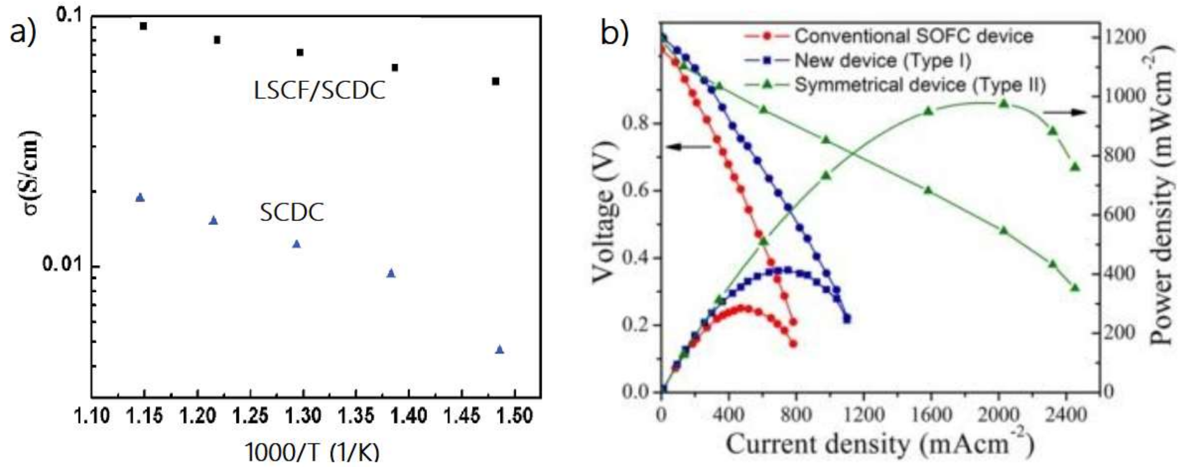

Figure 1 Ionic conductivities (a) and fuel cell performances (b) between ionic SrCa-codoped ceria (SCDC) and a semiconductor $LaSrFeCoO_3$ and SCDC heterostructure nanocomposite. Type I: LSCF/SDC membrane fuel cell; Type II: the fuel cell designed by/band alignment compared to conventional SCDC electrolyte fuel cell (b).

New scientific understanding has been established between conventional ionic electrolyte-based fuel cell and semiconductor-based device. Figure 2 displays fuel cells from anode, electrolyte and cathode device [1] to semiconductor-ionic fuel cell based on semiconductor heterostructure nanocomposites with both electrolyte and electrocatalyst functions. The fuel cell redox, i.e. hydrogen oxidation and oxygen reduction reactions can then be realized from macro-scale [1] to nano-scale on particles [2].

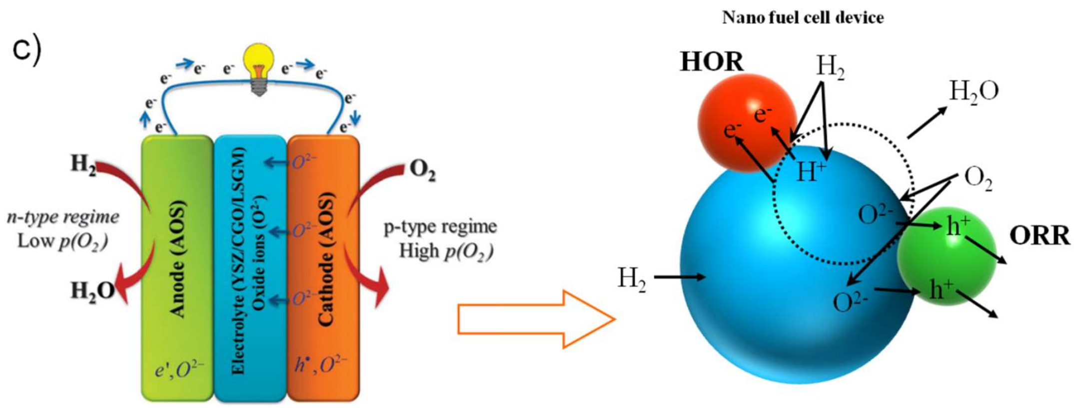

Figure 2 Conventional anode, electrolyte and cathode fuel cell can be realized by semiconductor–ionic heterostructure nanocomposite device

Tuning semiconductors and heterostructure nanocomposites to ionic conductivity and high electrocatalyst can be developed as a very effective approach to develop high ionic conducting and electrocatalyst materials for new generation fuel cell technologies and fundamentals of Semiconductor Electrochemistry. A number of novel devices have been demonstrated by various semiconductor junctions, e.g. bulk hetero p-n junction, planar p-n junction, Schottky junction, all are designed by energy bands and alignments. [2-4]

References

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