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Materials chemistry in borohydride fuel cells development

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Chemical and electrochemical reactions are important in developing new and cost effective materials for fuel cell development. A chitosan-based chemical hydrogel membrane and catalyst binder were developed by the authors and used in alkaline Direct Borohydride Fuel Cells (DBFCs). The chitosan-based borohydride fuel cell gave more than 50 % higher power performance than the commercial Nafion-based one. The authors are the first to develop a chitosan membrane which resulted in much higher power density than the commercially used Nafion-based membranes. The chitosan-based catalyst binder also gave about 20% higher power density values than Nafion as catalyst binder. This chitosan-based membrane has also been successful in alkaline ethanol fuel cells. The estimated cost of chitosan-based membrane is less than 10% of the cost of Nafion. For borohydride electro-oxidation, an effective anode consisting of Ni-based composite electrocatalysts loaded on Ni foam substrate was developed and employed. The use of Ni-based catalyst reduces the cost of fuel cell without compromising its performance. Thin film electrode was prepared by electroless plating and physical vapor deposition. A nanoscale thin film anode delivered comparable power performance to an ink pasted electrode with a much higher catalyst loading. Chemical and electrochemical aspects of these materials in preparing polymeric membrane and electrode and their performance results will be presented in this paper. The effect of these materials in reducing the cost of fuel cells will be also presented in this paper.

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The bimodal effect of the bulk modulus of rare-earth titanate pyrochlore

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First-principles calculations have been carried out to study the bulk modulus, the lattice parameters and the bond length of $RE_2M_2O_7$ (RE=La, Sm, Eu, Gd, Tb, Dy, Ho, Er, Tm, Yb, Lu; M=Ti, Sn) pyrochlores. The relationship of the bulk modulus and the bond length of RE2M2O7 have been analyzed qualitatively. Both the bulk modulus and the <RE-O_{48f}> bond present the "bimodal effect" and <RE-O_{48f}> bond may have a significant effect on the bulk modulus. The bimodal effect means certain properties of lanthanide elements and compounds will not change linearly with the increase of atomic number of lanthanides but present two peaks or two valleys in Eu and Yb positions.

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