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Advanced nonlinear observer and controller for control of auxiliary component in PEM fuel cells

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Fuel cells called zero emission systems PEMFCs are particularly proper and attracted for usage in transportation such as passenger cars, buses and aircrafts because of their fast startup time, high power density and favorable power-to-weight ratio. The Auxiliary components of the fuel cell are divided into four different interconnected subsystems: the air flow (breathing), the hydrogen flow, the humidity, and the stack temperature subsystem, respectively. Oxygen starvation during fast load changes and load disturbances is a complicated phenomenon and major problem in PEM fuel cell operation. This occurs during rapid increase in load. To avoid oxygen starvation and hop spot phenomenon, which requires precise control of the air-feed system and the oxygen excess ratio in the cathode side, it must be regulated around the constant value to cope with the oxygen starvation. The air-feed system consists of a motor air compressor connected to the cathode side via a supply manifold. The main manipulated variable to control of breathing subsystem is the air flow, which is manipulated through the Moto-compressor. Severe nonlinearity of the fuel cell system, modeling error and parametric uncertainties are the significant challenges in the linear control approaches. This research work presents an overview of nonlinear control approach to control of auxiliary component another section of nonlinear approaches about nonlinear observer which provides some essential requirements to be used in a sensorless control. The observer design technique is proposed to estimate some key states for estimation and control of oxygen excess ratio in PEMFC that is suggested to prevent of the fuel cell damage.

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Improving the electrochemical performances of $Li_3V_2(PO_4)_3$ and $LiTi_2(PO_4)_3$ by ion doping

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$Li_3V_2(PO_4)_3$ (LVP) is a potential cathode for advanced lithium ion batteries. However, its electrochemical performance is limited by the poor electronic conductivity. Ion doping is an effective method for improving electronic conductivity. Ion doping at different sites were explored. Bi doped and B doped LVP were synthesized via a sol-gel method. All the samples remain the crystal structure of LVP. $Li_3V_2(P_{0.97}B_{0.03}O_4)_3$/C and $Li_3V_{1.97}Bi_{0.03}(PO_4)_3$/C deliver excellent electrochemical performances, such as specific capacity, stability and rate performances. The excellent electrochemical performance can be attributed to its larger Li ion diffusion, smaller particle size, higher structural stability and electronic conductivity induced by ion doping. $LiTi_2(PO_4)_3$ (LTP) is a candidate anode for aqueous lithium ion batteries. Its electrochemical performance is also limited by its low electronic conductivity. The first anion ion doped LTP was studied here. We successfully synthesized a series of F-doped $LiTi_2(PO_4)_{3-x}F_x$(x=0, 0.06, 0.12, 0.18) /C nanoparticles samples by sol-gel method. F doping improves the discharge voltage platform and structure stability, reduces the particle size and band gap. As a result, the rate and cycle stability are enhanced obviously.

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