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A Selective and Fast Hydrogen Sensor Using Doped-$LaCrO_3$ as Sensing Electrode

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Abstract : As a clean energy, hydrogen shows many advantages such as renewability, high heat value, and extensive sources and may play an important role in the future society. However, hydrogen is a combustible gas because of its low ignition energy (0.02mJ) and wide explosive limit (4% ~ 74% in air). It is very likely to cause fire hazard or explosion once leakage is happened and not detected in time. Mixed-potential type sensor has attracted much attention in monitoring and detecting hydrogen due to its high response, simple support electronics and long-term stability. Typically, this kind of sensor is consisted of a sensing electrode (SE), a reference electrode (RE) and a solid electrolyte. The SE and RE materials usually display different electrocatalytic abilities to hydrogen. So hydrogen could be detected by measuring the EMF change between the two electrodes. Previous reports indicate that a high-performance sensing electrode is important for improving the sensing characteristics of the sensor. In this report, a planar type mixed-potential hydrogen sensor using $La_{0.8}Sr_{0.2}Cr_{0.5}Mn_{0.5}O_{3-\delta}$ (LSCM) as SE, Pt as RE and yttria-stabilized zirconia (YSZ) as solid electrolyte was developed. The reason for selecting LSCM as sensing electrode is that it shows the high electrocatalytic ability to hydrogen in solid oxide fuel cells. The sensing performance of the fabricated LSCM/YSZ/Pt sensor was tested systemically. The experimental results show that the sensor displays high response to hydrogen. The response values for 100ppm and 1000ppm hydrogen at 450 ºC are -70 mV and -118 mV, respectively. The response time is an important parameter to evaluate a sensor. In this report, the sensor response time decreases with increasing hydrogen concentration and get saturated above 500ppm. The steady response time at 450 ºC is as short as 4s, indicating the sensor shows great potential in practical application to monitor hydrogen. An excellent response repeatability to 100ppm hydrogen at 450 ˚C and a good sensor reproducibility among three sensors were also observed. Meanwhile, the sensor exhibits excellent selectivity to hydrogen compared with several interfering gases such as NO_2, CH_4, CO, C_3H_8 and NH_3. Polarization curves were tested to investigate the sensing mechanism and the results indicated the sensor abide by the mixed-potential mechanism.

Keywords : fire hazard, H_2 sensor, mixed-potential, perovskite
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