In-situ Synthesis of an Auxiliary Electrode of Solid Electrochemical Sulfur Sensor by CaAl_4O_7 Coating

Tianpeng Wen, Jingkun Yu*, Tao Liu, Endong Jin, Xinghui Hou, Yuting Zhou

School of Metallurgy, Northeastern University, Shenyang 110819, PR China

*E-mail: han921224@sina.com

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A novel auxiliary electrode $\text{CaAl}_4\text{O}_7+\text{Al}_2\text{O}_3+\text{CaS}$ used for solid electrochemical sulfur sensor, was synthesized by the in-situ reaction of CaAl_4O_7 coating on the surface of the $\text{ZrO}_2(\text{MgO})$ electrolyte tube by: $\text{CaAl}_4\text{O}_7+[\text{S}]=\text{CaS}+2\text{Al}_2\text{O}_3+[\text{O}]$. The CaAl_4O_7 coating was synthesized using aluminum nitrate solution and calcium hydroxide solution as raw materials and then was fabricated on the surface of the $\text{ZrO}_2(\text{MgO})$ electrolyte tube using solid sintering technology at 1500 °C. The microstructure of the coating was dense and well combined with the $\text{ZrO}_2(\text{MgO})$ electrolyte. The solid electrochemical sulfur sensor $\text{Fe}||[\text{S}]_{\text{Fe}}|\text{CaAl}_4\text{O}_7|\text{ZrO}_2(\text{MgO})|\text{Cr}+\text{Cr}_2\text{O}_3|\text{Mo}$ was assembled and tested in the carbon-saturated molten iron at 1500 °C. The results showed that the sensor had a good stability and accuracy, and the CaAl_4O_7 coating was converted to $\text{CaAl}_4\text{O}_7+\text{Al}_2\text{O}_3+\text{CaS}$ when the sulfur sensor was inserted into the molten iron. The phase composition and microstructure of the synthesized auxiliary electrode were investigated after the sulfur sensor was tested, indicating that the auxiliary electrode coating with a thickness of 40-50 μm was synthesized. The empirical formula of the sulfur sensor was obtained as follows:

$$E(\text{mV}) = 45.89 \ln[\text{wt} \% \text{S}] + 24.39$$

Keywords: Coating; Auxiliary electrode; Sulfur sensor; Solid electrolyte; In-situ synthesis

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