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Oxygen Evolution Anode Composed of Electrolessly Deposited Mn-Mo-Sn Oxides for Seawater Electrolysis

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Summary

In seawater electrolysis for hydrogen production the anodic reaction should not be chlorine evolution but oxygen evolution. We revealed that the $Ir_{1-x}Sn_xO_2$ double oxides have better protectiveness against oxidation of titanium than IrO_2. The $Mn_{1-x-y}Mo_xSn_yO_{2+x}/Ir_{1-x}Sn_xO_2$/Ti anode showed more than 99.9% oxygen evolution efficiency for 4200 h in the electrolysis of 0.5 M NaCl solution of pH 1 at 1000 Am^{-2}.

The oxide growth on the titanium substrate was unavoidable due to the inward diffusion of oxygen through electrocatalyst and intermediate layers during oxygen evolution. This resulted in the decrease of oxygen evolution efficiency due to electrocatalyst detachment. The improvement of durability of anode and establishment of cheap manufacturing processes are necessary for practical use of an oxygen evolution anode.

In the present work, the authors examined the performance of anodes deposited electrolessly from Mn^{2+}, Mo^{6+}, and Sn^{4+}solutions containing oxidizing agent. It found that the g-MnO_2 type $Mn_{1-x-y}Mo_xSn_yO_{2+x}$ anode deposited electrolessly from 0.48 M $MnSO_4 \cdot 5H_2O$, 0.0144 M $Na_2MoO_4 \cdot 2H_2O$, 0.0288 M $SnCl_4 \cdot 2H_2O$, 0.16 M $NaBrO_3$ solution of pH-0.09 at 30 ºC showed more than 99% oxygen evolution efficiency in the electrolysis of 0.5 M NaCl solution of pH 1 at the current density of 1,000 Am^{-2}. However the durability of the anode was much smaller than that of the anode deposited anodically, and the oxygen evolution efficiency decreased to about 97 % for 100 h.

The surface of the $Mn_{1-x-y}Mo_xSn_yO_{2+x}$ anode deposited electrolessly became rough to consist of minute crystals. We guessed that it was useful to one of pretreatments to improve the adhesion of $Mn_{1-x-y}Mo_xSn_yO_{2+x}$ electrocatalyst. The anode deposited anodically after oxide deposition electrolessly has higher durability performance than that of the anode deposited anodically.