Electrochemical fabrication of V-4Cr-4Ti alloys from the mixed oxides in a eutectic $CaCl_2$-NaCl melt

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V-4Cr-4Ti alloys exhibit important advantages as a candidate structural material for fusion reactor first-wall and blanket applications. V-4Cr-4Ti alloys were prepared by direct electrochemical reduction of the solid mixture of V_2O_3, Cr_2O_3 and TiO_2 in molten $CaCl_2$-NaCl melt at 1073K. The influence of cell voltage and electrolysis time on the electrolysis process was reported. The microstructure and phase compositions of the products were analyzed by scanning electron microscopy (SEM) and X-ray diffraction (XRD) during the electrolysis process. The results showed that V-4Cr-4Ti alloys can be obtained at the voltage of 3.1V and the time of 0.5h. The reduction process involved Cr_2O_3 was reduced to Cr metal firstly, thereafter V_2O_3 and TiO_2 was reduced to low-valence oxide of vanadium and titanium. The reduction rate increases with increasing cell voltage, lots of perovskite oxide formed during the electrolysis process. With the increase of the voltage, electrochemical reduction rate increased on the surface of electrode, the current rapidly decreased, and finally reached a stable value at a short time, which is beneficial to accelerate the transferring of oxygen ions. With the increase of time, the particles size of new generated product is less than1μm after 120min of electrolysis it becomes smaller and uniform.

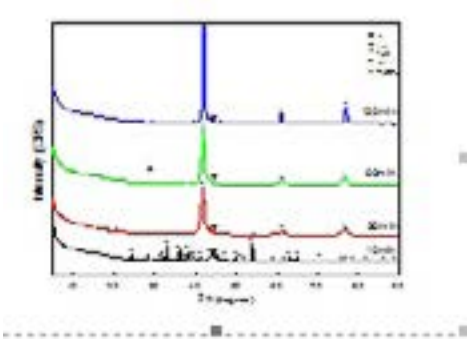

Figure 1: XRD patterns of the products at different electrolysis time.

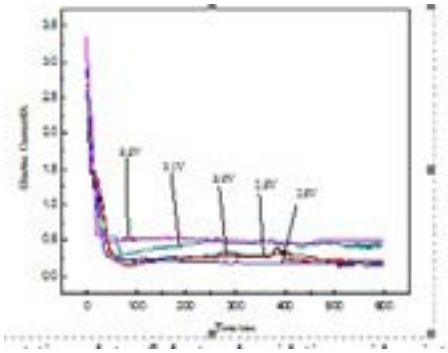

Figure 2: Current-time plots of electro-deoxidation oxide mixture at different electrolytic voltage.

Recent Publications

- Barabash V, Federici G, Linke J, Wu C H (2003) Material/plasma surface interaction issues following neutron damage. Journal of Nuclear Materials. 313-316:42-51.
- Xiao W, Wang D H (2014) The electrochemical reduction processes of solid compounds in high temperature molten salts. Chemical Social Reviews. 43(10):3215-3228.
- Kar P, Evans J W (2008) A model for the electrochemical reduction of metal oxides in molten salt electrolyte. Electrochimica Acta 54:835-843.
- Juzeliunas E, Cox A, Fray D J (2012) Electro-deoxidation of thin silica layer in molten salt-Globular structures with effective light absorbance. Electrochimica Acta 68:123-127.
- Alexander D T L, Schwandt C, Fray D J (2011) The electro-deoxidation of dense titanium dioxide precursors in molten calcium chloride giving a new reaction pathway. Electrochimica Acta.56:3286-3295.

Biography

Xiaozhou Cao received his BS in 2003, MS and PhD degrees in 2008 with Professor Zhuxian Qiu from Institute of Nonferrous Metallurgy at Northeastern University. He joined the Institute of Metallurgical Resources and Environmental Engineering at Northeastern University since 2008. His current research focuses on molten salt and ionic liquid electrochemistry to seek a simple and environmentally friendly way to produce the corresponding parent metals and alloys.

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