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The Technology of the Synthesis of Electrode Materials Made of Scheelite Concentrate Using Aluminothermy Method

[1, 2] V. D. Vlasenko

[1]Computing Center of FEB RAS, Khabarovsk, Russia
[2]Pacific National University, Khabarovsk, Russia

Abstract

The results of the synthesis of scheelite concentrate materials technology for electric erosion machining of the worktop of cars' details are listed in the work.

Keywords: electrical erosion machining, the scheelite concentrate, the aluminothermy

1. Introduction

Developing materials that meet the required functional specifications is the most important task of modern materials science. Developing materials that are used for coating of the detail's worktop is one of the promising directions. Such materials handle high temperatures, corrosive medium and great loadings.

Alloys based on tungsten and titanium carbide are often used for creating of coating materials. But these materials don't always meet all requirements, they are rare and expensive. Coatings are fragile and can't be used for a long time.

Using of minerals concentrates and direct recycle of the mineral associations in concentrates for getting of compact electrode used in electrical erosion machining (EEM) is a new direction in a creating coatings of multi-component metal compounds area.

The aluminothermy method was used as a technology of synthesis of electrode materials for an electrical erosion machining of scheelite concentrate [1-4].

The reduction of oxides and other metal alloys by the aluminum, magnesium other reductive metals while using non-metal, slag-forming material and elements is the essence of the method. The control mode during the reaction allows to divide the composition of the charge into two parts: metal and salt (slag) phases. The required electrode appears in the metal phase.

The synthesis requires high temperature (more than 2450 ^{0}C) and air environment. For the full reaction, sufficient duration of the high temperature, flow ability and seaplaque in the composition of the charge some extra elements are used. The correlation of the charge components is précised in the empirical path.

The aim of the performed work is the determination of the correlation of the charge composition of the Far East minerals, energetic, physical and technological processes and operating characteristics of the coatings that appear as a result during the reaction.

2. Materials and Methods

For synthesis of electrode materials by the aluminothermy method (metallothermy) scheelite concentrate was used.

The scheelite concentrate has the following composition, mass. %: WO_3 – 55.4; CaO – 19.8; SiO_2 – 7.96; MgO – 2.45; MnO_2 – 0.02; P_2O_5 – 4.9; TiO_2 – 0.25; Al_2O_3 – 0.78; Fe_2O_3 – 5.29; FeO – 0.72; K_2O – 0.17; Na_2O – 0.18; As – 0.45; SO_3 – 0.10.

The aluminothermy reaction looks the following way:

$$p/nM_nX_m + mM^1 + sM_s + aM_T + kM_F = pM + m/nM^1_nX_p - \Delta H^0_\tau, \quad (1)$$

где M_nX_m – the reductive compound, M^1 – reductive metal, M_s – alloy-forming and M_T – fuel extras, M_F – fluxes, M – reduced metal, $M^1_nX_p$ – slag compounds forms during the reaction, a, s, k, m, n, p – stochiometric coefficients, ΔH^0_τ – exothermic effect of the reaction during the T temperature. The mixture that is put into the reactor (M_nX_m и M^1) for the process is called metallothermy charge and contains fluxes, fuel and alloy-forming extras. Fluxes are used for changing of the slug properties. Fuel extras are used for controlling the exothermic process. Alloy-forming extras are used for forming alloys with better operational characteristics. They can be used in charge composition as a compounds and then can be reduced to metals in the metallothermy reaction.

As a alloy-extras in the charge compounds were used: Cr_2O_3, MoO_3, NiO, Co_3O_4, $Zr(SO_4)_2$, FeTiO, Fe_2O_3. They influence on the technological properties of the electrode materials and operating characteristics of the coatings obtained during the reaction. Also the method of optimization of the charge composition was developed. It provides the largest amount of metal formed for the new electrode of the following compositions: W-Fe, W-Ni, W-Cr, W-Zr, W-Mo-Co, W-Ni-Mo, W-Ni-Zr, W-Cr-Co, W-Ni-Cr, W-Ni-Co, W-Fe-Ti, W-Co, W-Cr-Mo.

Technological scheme of the producing of electrode materials is represented on the Figure 1. Compound of the metal phase and new electrode materials, that are got during the reaction with the scheelite concentrate is defined by chemical analysis in several steps. Also atomic absorption analysis that are done on a special x-ray (x-ray pictures for W-Ni, W-Co can be seen on the Figure 2).

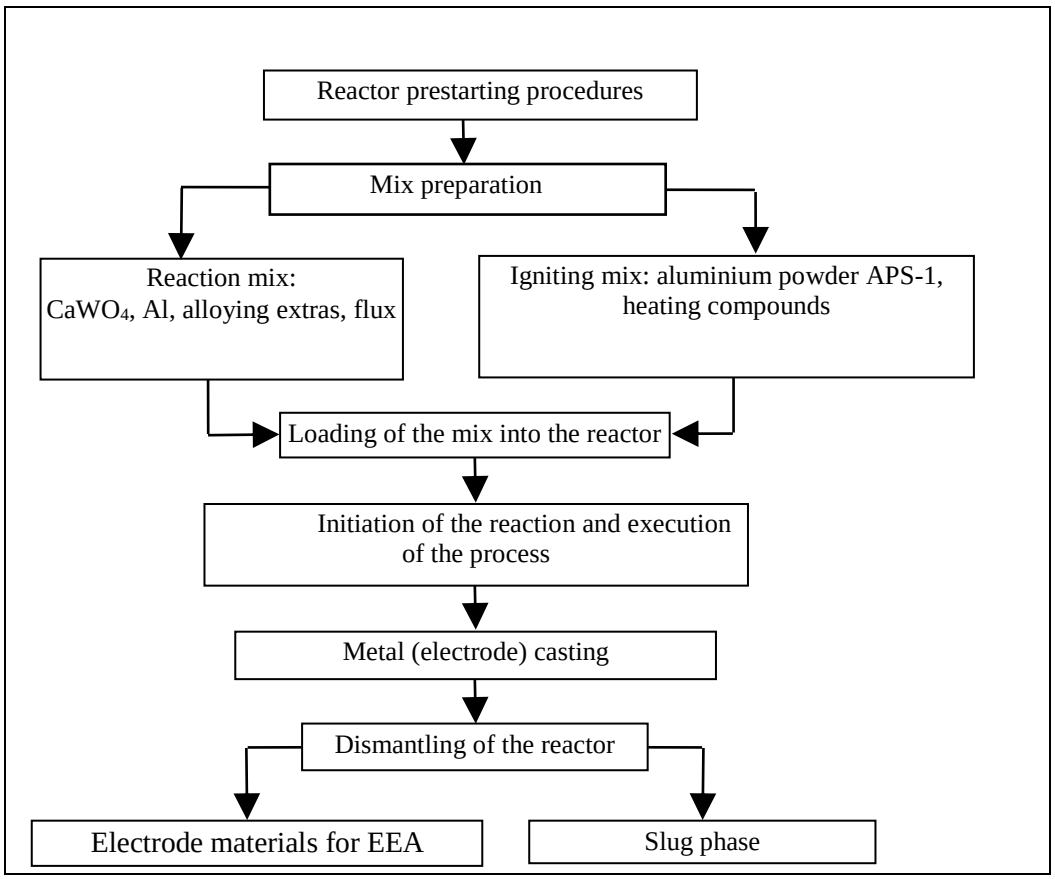
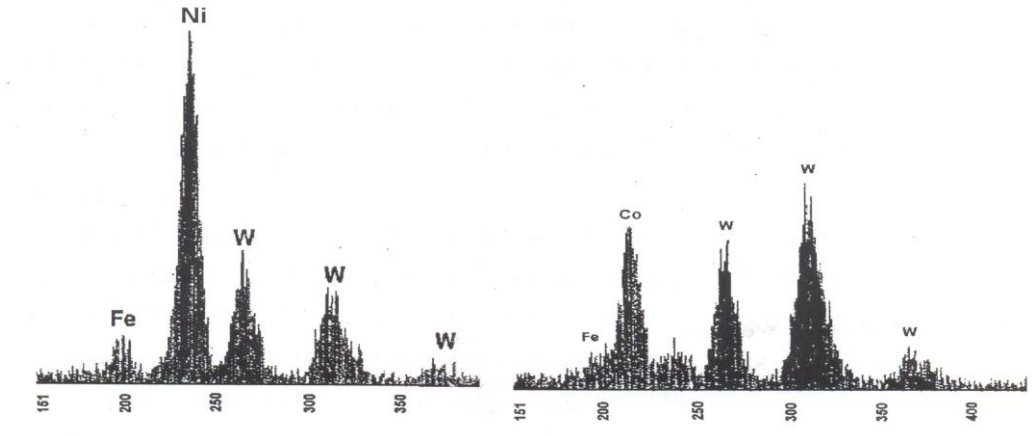


Fig. 1. Technological scheme of the producing of electrode materials



a) b)

Fig. 2. X-ray pictures: a) W-Ni, b) W-Co

For testing materials of the compact electrodes adjustments EEM model TOGY-102 was used.

Element and phase compound of the gotten materials and covers were investigated. Technical, mechanical and operating properties of these elements were assessed and compared with the electrodes of standard alloys (ВК6, ВК8) and wolfram, that were obtained by the method of powder metallurgy. Experiments were conducted on the steel 40ХНВГ, that are often used in auto industry.

3. Conclusions

1. Using the aluminothermy method new electrode materials were got using mineral materials (scheelite concentrate). The process is environmentally friendly and needs minimal energy.

2. The dependence of the thickness of the coating formed by the microhardness, the amount of run-out, coefficient of friction on the type of powder material and process conditions ЭИЛ were defined.

3. The best heat resistance are given by EEA of materials with the next temperatures 700…900 ^{0}C – W-Cr, W-Ni, W-Ni-Cr; 700…800 ^{0}C for W-Ni-Mo, W-Ni-Zr and 700 ^{0}C for W-Cr-Co.

4. During the investigation big economical efficiency were determined. The cost of using materials that are got of scheelite concentrate using the aluminothermy method is reduced by 15-20 times compared to the electrodes made of alloy BK8. All tests were run with the use of high temperatures, hard friction and no grease.

5. Some new electrode materials for general and special-purpose were got. Technology of the production makes possible organization of the production at facilities located directly in the areas where minerals are mined.

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