Vanadium-bearing phases in crystallized ferroalloy slags

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Abstract: Phase compositions and microstructures of waste solid slags obtained during the production of ferrovanadium and ferromolybdenumvanadium alloys have been studied. The slag phase composition and the vanadium distribution have been investigated using optical microscopy, X-ray diffraction, scanning electron microscopy (SEM) and electron microprobe techniques (EPMA). A series of simple and complex oxides, calcium aluminates and silicates were identified, including a new phase SVCA (complex calcium vanadium oxide-silicate) with the composition $\text{Ca}_4\text{Al}_{15.14}\text{V}_{5.15}\text{Mg}_{1.0}\text{FeO}_{0.026}\text{Ti}_{0.3}\text{MnO}_{2.04}\text{Si}_{2.36}\text{O}_{40}$, space group $P\overline{1}$ and lattice parameters $a = 10.273$, $b = 10.634$, $c = 8.808$ Å, $\alpha = 106.24$, $\beta = 95.71$, $\gamma = 124.47^\circ$, $z = 4$. In a previous investigation the crystal structure of SVCA, which is of aenigmatite type, was determined and refined to $R = 0.046$.

Key-words: ferroalloy slag, vanadium phase, SVCA phase, aenigmatite group.

Introduction

An experimental plant for ferroalloys, which is situated near the city of Sofia, produces about 8–10,000 tons of waste slags per year. Although these slags do not find any use at present, they represent an interesting subject not only for scientific investigations, but also as a new secondary raw material to be used in the building and refractory industry. This paper presents chemical and X-ray data of slag phases obtained from the investigation of solid ferrovanadium and ferromolybdenumvanadium slags from this plant.

The investigation of crystallized metallurgical slags provides rich and useful information on their phase composition and microstructural character. Some slag phases have natural analogues as minerals, whereas others are found in technical products only. The study of slag phases allows for comparisons with and explanations on the composition and genesis of more complicated compounds which also occur as minerals. There are many papers which deal with this problem (Butler, 1977, 1978; Scott et al., 1986; Wearing, 1982, 1983, 1983a; etc.).

Experimental procedure

The investigations have been carried out on different kinds of chilled and slowly cooled samples of solid, waste and intermediate slags. Single crystals of SVCA with dimensions of 0.2–1.5 mm were extracted from slag cavities.

The chemical composition of some typical ferrovanadium and ferromolybdenumvanadium slags were determined by routine methods of silicate analysis. The crystalline slag phases were studied using the following methods: optical microscopy, X-ray diffraction, SEM and EPMA. The microprobe analyses were performed on a JEOL SUPERPROBE 733. Operating conditions were as follows: 20 kV accelerating potential, $0.6 \times 10^{-9}$ Å specimen current, 60 live-seconds counting time, 75° take-off angle. Data correction (ZAF) was accomplished using the EG & G Ortec System 5000. The X-ray investigations on powder and single-crystal samples were carried out using an automatic “Philips” 515 diffractometer, Cu Ka radiation, Dif 2θ limit for indexing: 0.200 deg., figures of merit: $F_{20} = 0.5$ (0.064, 666), $M_{20} = 0.6$, and “Syntex” P 1 diffractometer, Mo Ka radiation.