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Bead One HF application for borate fusion of titanium enriched slag and ilmenite

Abstract

We used the Bead One HF induction furnace to produce borate glass discs of titanium-slag and ilmenite. The sample material was fused with a common Lithiumtetraborate Flux at 1050 °C resulting in perfectly homogeneous 32 mm beads. EDXRF analysis revealed a high reproducibility demonstrating that the fusion method is excellently suitable for titanium processing applications.

Key words

• **Borate Fusion** • **Bead One HF** • **EDXRF** • **Titanium processing** • **Ilmenite** • **Iron**

Introduction

Borate fusion is a frequently used technology for determination of elements within a sample. Fusion has been shown to be a reliable and easy preparation method for iron ore, cement or bauxites and to guarantee precise analysis results. However, the same method might also be appropriate for material bearing high Ti contents.

For this study, we used ilmenite powder and titanium bearing slag in order to investigate reliability of the fusion method and analysis results. Ilmenite is the most important mineral for titanium production worldwide. Ti-slag might be used for the chloride acid process in which Ti is reduced with carbon and oxidized again with chlorine.

Method

For a 32 mm bead, 0.5 ± 0.0001 g sample powder (*ground to < 150 µm*) and 6 ± 0.0003 g Lithiumtetraborate ($Li_2B_4O_7$)) were weighed into a $Pt_{95}Au_5$ crucible.

The Bead One HF induction furnace was used for melting and casting of the material. The material was fused at 1050 °C for 15 min including 8 min of rocking in order to homogenize the melt and remove remaining gas bubbles. After having dissolved the sample material the borate melt was poured into a pre-heated platinum dish and cooled passively and actively *(air jet).* From each sample type three glass beads were produced and measured by an EDXRF spectrometer.

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Results- Calibration

A PANalytical Epsilon 3XL energy dispersive X-Ray Spectrometer was used to obtain elemental distribution of the samples. We applied a standardless measurement program. Table 1 shows the measured raw intensities as well as the standard deviation of both samples types.

The range of the intensities varied between 40 (Mg) up to 64000 (Fe in ilmenite) counts. The standard deviation was low with approximately 250 ≈ 0.5 % for Titanium in ilmenite and slag samples.

Table 1: Raw intensities of analyzed elements within the ilmenite and titanium-slag samples.

	Raw Intensities								
ID	**Mg**	**Al**	**Si**	**Ca**	**Ti**	**V**	**Cr**	**Mn**	**Fe**
Ilmenite 1	40.9	178.7	374.4	-	27342.6	294.9	130.9	1044.2	63221.0
Ilmenite 2	44.4	177.3	381.6	-	27639.6	311.0	125.1	1051.3	63398.9
Ilmenite 3	40.9	171.9	377.8	-	27627.6	309.2	124.3	1048.7	63671.8
σ	1.7	2.9	3.0	-	137.2	7.2	2.9	2.9	185.4

	Raw Intensities								
ID	**Mg**	**Al**	**Si**	**Ca**	**Ti**	**V**	**Cr**	**Mn**	**Fe**
Slag 1	92.0	444.4	1149.9	52.1	54339.3	652.3	172.5	2196.3	19355.2
Slag 2	94.5	442.9	1172.4	52.7	54192.3	664.5	177.1	2202.5	19368.4
Slag 3	92.7	444.1	1169.3	50.3	53750.9	661.4	172.7	2175.4	19200.2
σ	1.1	0.7	10.0	1.0	250.1	5.2	2.1	11.6	76.4

Conclusion

The borate fusion process is suitable for samples from titanium production. Ilmenite -as the most important titanium ore- and titanium bearing slag can be easily fused in the Bead One HF using only Lithiumtetraborate. This application is not limited to the induction furnace but might be also adapted for the Bead One R benchtop muffle furnace. The resulting glass beads show an excellent shape and stress distribution. Furthermore, element analysis of chemical composition reveal a low standard deviation even with standardless measurement on a benchtop EDXRF. Fusion is successfully performed at temperatures as low as 1050 °C. High temperatures increase the loss of volatile elements and impact chemical compounds of interest. Therefore, lower fusion temperatures (~ 1050 °C) are clearly preferred for sample preparation.

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