The implementation of a DSSSD in the upgraded boron analysis at LIBAF for applications in geochemistry

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Introduction

Boron and boron-related analyses have been performed at LIBAF (Lund Ion Beam Analysis Facility) for almost 20 years. For the analysis the nuclear reaction p+10B is used with beam energy just below 700 keV where the reaction has a broad resonance. This reaction emits three alpha particles with energies much higher than the elastically scattered proton, which can easily be discriminated and counted as a function of beam energy. In the original set-up an annular surface barrier was used to detect the alpha particles.1-3 Then an analysis current of 100-500 pA could be used together with the focused ion beam. This kept the count rate below 10 kHz, which was considered acceptable for this kind of analysis. In this paper we will describe and evaluate the upgrade of the system from a single detector to a DSSSD (double-sided silicon strip detector).4

Experimental System

Experimental site: Lund Ion Beam Analysis Facility 5,6
Beam energy: 700 keV and 610 keV protons
DAQ: Combined CAMAC (scan) and VME (energy)
Scan: Typical 128×128 with 10 μm step (smaller for high-resolution runs)
Detector: Double sided silicon strip detector with 64 sectors on the front side and 32 rings on the back side
Trigger: Low threshold on rings (CR) and high threshold on sectors (B) in coincidence
Charge normalization: Internal B-standard in sample. Charge and CR used for normalization.

Results

Apart from analyzing two sets of crystals regarding boron concentration and distribution the performed experiment was intended as an evaluation of the upgraded system with the new DSSSD detector.

In figure 1 energy spectra from analyzes of a tourmaline standard are shown. The upper curve is the raw spectrum taken with a current of 10 nA, the second curve (scaled a factor of 10) is the same set of data but gated on the multiplicity condition 1. The third curve is a spectrum taken with 10 nA and shows the same shape as the high current spectrum.

An illustration of what can be achieved with a high resolution run with good statistics is shown in figure 4.

Quantitative analysis is the primary goal of the presented technique. In the table the different steps going from counts to ppm are illustrated for the epoxy sample. First a suitable area from a scan is selected and the number of B-counts is extracted from this area. The corresponding charge is extracted and the data is normalized. The background is subtracted and the concentration is normalized to the tourmaline standard.

Conclusion

- New detector set-up tested for boron analysis - improved the system significantly.
- Can be operated with very high count-rate ~ up to 200 kHz or higher.
- Good detection limits - depends on sample composition and beam energy.
- High resolution mapping possible with good result.

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