DETERMINATION OF TRACE CONCENTRATION OF BORON IN ADU BY THE NUCLEAR TRACK TECHNIQUE

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A method for the determination of boron concentration in extracted (NH₄)₂ U₂O₇ · H₂O (ADU) has been used. One ml of the aqueous solution is irradiated with thermal neutrons from a 10 Ci Am/Be neutron source with a flux of 0.2 · 10⁶ n · cm⁻² · s⁻¹ and thermal column in the IRT-5000 with a flux of about 10⁷ n · cm⁻² · s⁻¹. The alpha-activity due to the reaction \(^{10}\text{B}(n, \alpha)^{7}\text{Li}\) is recorded by a CR-39 alpha track detector. After the exposure, the alpha tracks are made visible in an optical microscope at magnification of 800X by etching the detector in 6N NaOH, and the track density is determined using calibration curves of known concentrations of boron. The boron concentration of the extracted ADU was found to be 5 ppm.

Introduction

Dielectric materials have been used extensively as SSNTD for mapping elemental distributions and concentration in solids.¹ It is now possible to select a detector/etchant combination that will produce the optimum track profile for specific charge particles e.g. polycarbonate detectors are used for fission fragments and \(\alpha\)-particles. CN is used to detect low energy protons, deuterons, tritons and \(\alpha\)-particles.² Recently the discovery of the plastic CR-39 by CARTWRIGHT, SHIRK and PRICE² have presented a major change in the role of plastic track detectors in science and technology owing to their very high sensitivity and resolution. In addition to its ability to register particles of lower specific ionization than CN, the CR-39 does not contain nitrogen and therefore does not produce a background of proton tracks from the reaction of thermal neutrons with nitrogen.

The \(\alpha\)-particles emitted from the nuclear reaction of \(^{10}\text{B}\) with thermal neutrons have sufficient energy to cause chemically etchable damage in an appropriately positioned detector. This is caused by the heavy ionization along their trajectory. Subsequent chemical etching of the detector enlarges the latent tracks to a size which is visible with an optical microscope.
Boron is an element which has been extensively studied using the track technique\textsuperscript{3} because the isotope $^{10}$B is present in such an abundance that there is little difficulty in pinpointing the nuclear reaction and its large thermal neutron cross section (3838 barn) for undergoing a ($n$, $\alpha$) reaction. The number of $\alpha$-tracks per unit area were shown to be proportional to the quantity of boron. DIN and HENDERSON\textsuperscript{4} have used CR-39 for quantitative boron mapping in minerals and rocks and this element was determined up to 2 ppm level.

In the present work CR-39 has been used to analyze the B concentration in extracted (NH$_4$)$_2$ U$_2$O$_7 \cdot$ H$_2$O (ADU) from the $^{10}$B($n$, $\alpha$)$^7$Li reaction.

**Experimental**

Five portions of 1 ml of the aqueous solution of uranium compounds (ADU) after the separation of uranium by solvent extraction system (100\% TBP-6MHNO$_3$),\textsuperscript{5} were dried onto small pieces of CR-39 plastic detector. Each specimen has been irradiated for 24 hours in a thermal neutron flux. 10 Ci Am/Be neutron source with a flux of $0.2 \cdot 10^5$ n $\cdot$ cm$^{-2}$ $\cdot$ s$^{-1}$ is placed in a wax shield as shown in Fig. 1.

After irradiation each detector is rinsed with distilled water to get rid of the remnants, etched for 2.5 hours in 6N $\cdot$ NaOH solution at 60 $^\circ$C and rinsed with 2\% HCl for 10 minutes and another 10 minutes in distilled water. After drying in an oven for 10–15 minutes, the CR-39 is mounted for microscopic examination using an optical

*Fig. 1. Irradiation arrangement with an Am–Be source*