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DETERMINATION OF URANIUM TRACE IN SOME SEMICONDUCTING MATERIALS BY NUCLEAR TRACK DETECTORS

S. K. CHAKARVARTI

Department of Applied Physics, Regional Engineering College, Kurukshetra 132119, Haryana, India

AND

M. M. DHAWAN AND K. K. NAGPAUL

Department of Physics, Kurukshetra University, Kurukshetra 132 119, Haryana, India

ABSTRACT

Fission track counting method has been applied to the trace determination of uranium in some semiconductors Se, Te, As_2S_3 (Glass), CdS, PbS, Pb–As–S and Pb–Sb–S in amorphous form. It has been found that the uranium is not uniformly distributed. Results indicate uranium concentration as low as 0·43 ppm in the homogeneous region and 77 ppm on the higher side in the heterogeneous region.

INTRODUCTION

ONE of the significant applications of solid state nuclear track detectors (SSNTD) lies in determining some trace elements[1] (U^{235}, B^{10}, Li^7, Li^6, O^{17}, K^{39}, Fe^{57}, S^{33}, Zn^{66}, etc.), in various materials. In the present investigations, attempt has been made to apply this technique to semiconductors for the determination of traces of uranium.

EXPERIMENTAL PROCEDURE

The method consists of placing suitable plastic detectors in close and intimate contact on both sides of the sample under investigation A standard sample with known uranium content or other isotope of interest is also included. All the samples are then enclosed in an aluminium capsule and the whole assembly irradiated to thermal neutrons of

known dosage. The fission fragments during the process produce latent damages in the detectors. After irradiation the detectors are etched with suitable etchants and scanned for track counting using optical microscope[1]. The uranium concentration in the unknown can be calculated using the relation

$$U_x = U_s \left(\frac{T_x}{T_s}\right)\left(\frac{I_s}{I_x}\right)\left(\frac{R_s}{R_x}\right)$$

where

U_x, U_s Uranium concentration in unknown and known standard in wt.-fraction, respectively.

$\frac{I_x}{I_s}$ — Ratio of fission track density in detector with unknown and known standard,

$\frac{I_s}{I_x}$ = Ratio of U^{235} and U^{238} in standard and unknown.

and

$\frac{R}{R_x}$ = Ratio of effective range of fission fragments in mg/cm^2 in standard and unknown,

(R_s/R_x) is a correction factor which is applied when the elemental composition of unknown and standard are different[2,3].

The semiconductors Se, Te, As_2–S_3 (glass), CbS, PbS, Pb–As–S and Pb–Sb–S were finely powdered and compressed to form pellets (~ 50 mg each). The standard used was a corning glass with composition 43 ± 1 ppm uranium, $I_s = 0{\cdot}0036$, 72% SiO_2, 12% CaO, 14% Na_2O and 2% Al_2O_3. A pellet was also made of this powdered glass. Cleaned and contamination free Lexan (Poly-Carbonate) plastic detectors were placed on both sides of these pellets. All the samples along with the standard glass were encapsuled and irradiated to a known dose (10^{15} n/cm^2) of thermal neutrons at BARC, Trombay, Bombay, India. It is expected that fast neutrons get thermalised at the point where these samples are exposed and their interference, if at all, is negligible. After irradiation the detectors were etched with 6N NaOH at 70° C for 20–25 minutes. The sides in contact with the pellets were scanned under optical microscope using 300 × magnification.

Concentration of thorium in these samples does not contribute significant tracks within the error of measurement (as in the case of terrestrial minerals[2]), since its cross section[4] for thermal neutrons is ~ 40 μb, which is extremely low as compared with the corresponding cross section of 582 b for U^{235}

The results obtained are given in Table I.

TABLE I

Uranium concentration in some semi-conductors

Sl. No.	Sample and number	Tracks counted	Tracks per graticular area	Uranium concentration, ppm	
				Uniform	Non-uniform
1.	Standard glass (U_s)	2006	27·1	43 ± 1	..
2.	Se (MM-11/2)	1652	6·97	5·5	..
		60	60·0	...	46·0
3.	Te (MM-11/3)	338	0·67	0·53	..
		84	84·0	..	66
		329	6·45	..	5·1
4.	As_2–S_3 (MM-11/4)	869	2·12	1·67	..
		48	48·0	..	38
5.	CdS (MM-11/5)	579	0·55	0·43	...
6.	PbS (MM-11/6)	1679	1·66	1·31	...
		392	98·0	..	77
7.	Pb–As–S (MM-11/7)	1465	1·09	0·80	...
8.	Pb–Sb–S (MM-11/8)	872	0·98	0·77	...

Though care was taken to eliminate any contribution from outside contamination, still there are chances of its contribution around the periphery of the detectors. Hence the outer regions were not used for measurements. The random observations were recorded making sure that uniform and non-uniform regions of uranium concentration were separately counted. In some of the samples like CdS, Pb–As–S and Pb–Sb–S, no clusters were observed in any of the graticules, although measurements were made upto 1300 graticules. In other cases, however, there were random regionc of non-uniform distribution and their concentrations are indicated in Table I.

The results indicate non-uniform distribution of uranium in some of the semiconductors. Although the information on bulk average uranium in tne samples may be useful, yet, spatial distribution measurements may be more important in structural characterization. Apart from low level (even fraction of a ppm) detection efficiency regarding trace determinations with better reliability, the technique also has the potential of micromapping the trace elements which is not provided by other usual techniques.

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ALL-INDIA SYMPOSIUM ON FLORISTIC STUDIES IN INDIA

(Organised by the Botanical Survey of India in Howrah from 16th November to 18th November 1977)

An All-India Symposium on "Floristic Studies in India—Present Status and Future Strategies" organized by the Botanical Survey of India was held at Howrah from 16th to 18th November 1977. Over 100 scientists participated in the Symposium. There was a very good representation of taxonomists from about 35 institutions and from different special groups of plants.

The papers presented in the Symposium were divided into 4 sections, viz., (*i*) Floristic studies, (*ii*) Role of educational and other institutions in floristic surveys, (*iii*) The herbaria and gardens of India, (*iv*) Status of studies in Cryptogams in India.

The Symposium was inaugurated by Prof. A. K. Sharma, FNA, Ghosh Professor and Head of the Department of Botany, Calcutta University, Calcutta. It was to be presided over by Dr. A. Ramachandran, Secretary to Government of India, Department of Science and Technology, New Delhi. Due to his inability to attend, his Presidential Address was read by Dr. (Mrs.) Manju Sharma. Professor M. B. Raizada, FNA, acted as a working President for the Inaugural Function.

Dr. S. K. Jain, Joint Director-in-charge, Botanical Survey of India, in his welcome speech narrated the brief history of floristic studies and the Botanical Survey of India, the present activities of the Survey and salient future programmes. The present status of knowledge in survey of different groups of plants was discussed and the lacunae in the knowledge brought out. Future strategies in exploration work were highlighted. A committee of 10 scientists representing different interests/disciplines discussed the proceedings and prepared some recommendations.

A unique feature of the Symposium was an "Opinion Poll" for the review of the Symposium. The delegates felt that the Symposium served a very useful purpose of exchanging thoughts between taxonomists and highlighting the importance of floristic survey for locating endangered habitats and plant species in India. The Symposium strongly recommended strengthening of plant taxonomic studies in the Survey and in Universities.