BG8500130

NEUTRON ACTIVATION ANALYSIS OF SEMICONDUCTOR SILICON

S. Apostolescu, Ana Pantelică, Maria Sălăgean
Institute for Physics and Nuclear Engineering
Bucharest MG-6, Romania

Abstract: Some romanian semiconductor grade silicon slides were analysed by INAA. Surface and volume contaminations of the samples have been studied.

INTRODUCTION

The analysis of impurity contents in semiconductor materials is an important problem since it is known that small quantities of these impurities can drastically change their mechanical and electrical properties.

EXPERIMENTAL

Many samples of semiconductor silicon slides of various types and different proveniences have been analysed. The analysis of only four romanian semiconductor silicon samples produced by the Institute for Research and Production of Semiconductor Materials is presented in this paper. The samples of n or p types materials having the resistivities between 40 Ω cm and 1.4 KΩcm were irradiated for 40 hours in a 1.4×10^{13}n/cm^2.s. flux. Before the irradiation the silicon slides were very cleamed and washed. A solution of 0.105 µg of Au and Soil-5 were used as standards. After 4 - 5 days cooling time the measurements have been carried out by using a Ge(Li) detector with 2 keV resolution coupled to a multichannel analyser. A gamma spectrum of the sample nr.3 measured for 2 hours after 4 days decay time is shown in figure 1.

RESULTS AND DISCUSSION

As, Au, Br, Co, Cr, Ga, Hf, Mo, Na, Sb, Zn, W elements were found out. From another spectrum of this sample, Fe could also be measured. Besides the elements before mentioned, Sc and Ni are present in some of the samples. The results expressed in 10^{12}atoms/cm^2 are given in table 1. The samples labeled 4 and 5 are the same type of semiconductor silicon, the difference consisting only in the way the samples have been treated prior to the irradiation.
Number 4 was very well washed in deionised water while number 5 was etched in a 3 : 1 : 1 mixture of acids (HNO_3, HF, CH_3COOH, respectively). All the other samples were etched in the above mixture of acids. The impurity contents are smaller in the sample 5 as compared to the number 4 as can be seen.

After these first measurements the samples have been etched for 5 minutes in a 5 : 3 : 3 mixture of acids (HNO_3, HF, CH_3COOH, respectively) and very thorougly washed in a shower of water. Measurements of 5 - 6 hours have been carried out for each sample. The concentration of the elements present into the volume of the samples is presented in table 2. Results are expressed in ppb.

A study of the variation of some element contents with succesive etchings of the samples after irradiation, is also presented in tabel 3. For this study the two samples namely 4 and 5 were chosen, i.e. the same type of silicon prepared in different ways before irradiation. The results are expressed in 10^{12} atoms. The succesive etchings of 2 minutes in a 5 : 3 : 3 mixture of acids were carried out. After the first etching a high decreasing of the element contents can be observed. A surface contamination of the silicon slides during cutting, polishing, washing and handling before and after their irradiation can be concluded.

After the second etching, element contents decreased in a variable ratio in 1 - 4 region while the third etching reveals that the sample elemental contents remains constant suggesting no further surface contamination.

A high content of the elements on the surface of the semiconductor silicon slides does indeed exist. An etching of 5 minutes after the sample irradiation in a 5 : 3 : 3 mixture of acids reveals only the volume contamination of silicon semiconductor slides.

TABLE 1 - Elemental content (10^{12}atoms/cm^2)

0	1	2	3	4	5
As	0.08±0.02	0.12±0.04	0.08±0.03	0.5±0.1	-
Au	0.0280±0.0006	0.0150±0.0003	0.0110±0.0002	32.1±0.4	0.243±0.005

0	1	2	3	4	5
Br	-	1.63±0.09	1.57±0.09	-	-
Co	0.5±0.1	0.9±0.1	1.3±0.1	9.3±1.6	1.1±0.7
Cr	7.3±0.9	3.6±0.6	3.5±0.6	-	-
Fe	80±40	67±60	132±65	-	-
Ga	-	1.4±0.4	0.6±0.3	0.06±0.01	0.07±0.02
Hf	1.5±0.1	-	0.03±0.01	-	-
Mo	0.49±0.05	0.82±0.08	0.62±0.01	14.1±3.5	2.2±0.7
Na	218±25	148±18	170±21	827±21	117±4
Ni	12±2	-	-	23±13	-
Sb	0.024±0.006	0.031±0.006	0.015±0.003	0.21±0.06	-
Sc	0.050±0.005	-	-	-	-
Zn	17±3	40±7	47±6	194±92	-
W	0.44±0.07	1.0±0.2	1.8±0.3	26.2±0.3	4.8±0.1

TABLE 2 - Elemental concentration (ppb)

Sample	Au	Mo	Na	W
1	0.051±0.004	-	-	-
2	0.005±0.002	-	-	-
3	0.003±0.001	-	-	-
4	0.0032±0.0003	0.03±0.01	0.49±0.07	0.013±0.003
5	0.0029±0.0002	0.05±0.02	0.50±0.02	-

TABLE 3 - Variation of some element contents (10^{12} atoms) with succesive etchings of the samples after irradiation

Sample 4

Element	Non-etching	First etching	Second etching	Third etching
Au	32.1±0.4	0.0229±0.0006	0.0050±0.0004	0.0038±0.0004
Mo	14.1±3.4	0.103±0.069	0.0589±0.0466	0.0685±0.0342
Na	827±21	6.5±0.8	5.91±0.73	5.1±0.7
W	26.2±0.3	0.024±0.005	0.0139±0.0038	0.0163±0.0050

Sample 5

Element	Non-etching	First etching	Second etching	Third etching
Au	0.24±0.01	0.00666±0.00053	0.00243±0.00032	0.0030±0.0002
Mo	2.2±0.7	0.286±0.066	0.108±0.053	0.1172±0.0486
Na	117±9	5.27±0.64	4.79±0.54	4.52±0.72
W	4.8±0.1	0.0055±0.0019	0.00286±0.00137	-

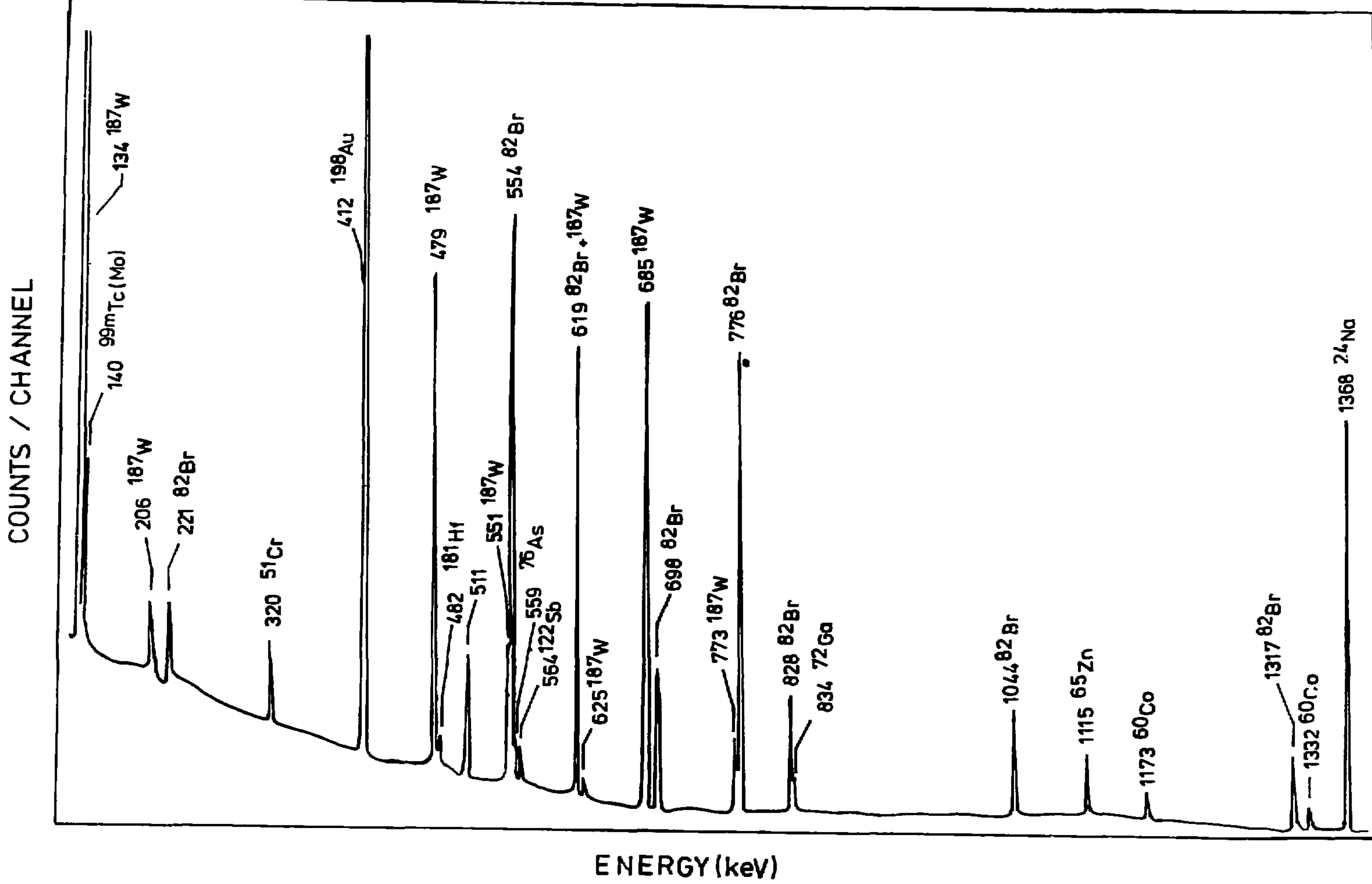

Figure 1.