In conclusion, we note that when carbon devitrified glass, boron nitride, and quartz glass are bombarded at room temperature with deuterium ions with an energy of 7.5 keV per deuteron practically all the incident ions are trapped in the specimen to doses of $4 \times 10^{17}$, $3.5 \times 10^{17}$, and $0.5 \times 10^{17} \text{ cm}^{-2}$, respectively. After these doses a reverse gas liberation appears and the state of saturation is gradually approached. As indicated by the results of experiments on gas liberation during irradiation and during heating after the irradiation, the mobility of the implanted deuterons is insignificant at room temperature. The accumulation of gas during implantation is described well by the model of local mixing with the values of the maximum attainable concentration of ion-implanted deuterium $7.3 \times 10^{22}$, $5.15 \times 10^{22}$, and $1.15 \times 10^{22} \text{ cm}^{-3}$, respectively, for carbon devitrified glass, boron nitride, and quartz glass.

LITERATURE CITED


YIELDS OF $^{42}\text{K}$ AND $^{43}\text{K}$ UPON IRRADIATION OF CALCIUM BY PROTONS AND DEUTERONS

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Of the two long-lived radioisotopes of potassium $^{42}\text{K}$ ($T_{1/2} = 12.36\text{ h}$) and $^{43}\text{K}$ ($T_{1/2} = 22.6\text{ h}$), the most widely used in nuclear medicine is $^{43}\text{K}$. It is necessary when choosing the method of producing $^{42}\text{K}$ to know the yields of $^{42}\text{K}$ and $^{43}\text{K}$. The method of producing $^{43}\text{K}$ by the reaction $^{40}\text{Ar}(\alpha,\text{p})^{43}\text{K}$ is well known. An argon gas target for producing $^{43}\text{K}$ has been described in [1], and the dependence of the $^{43}\text{K}$ and $^{42}\text{K}$ yields on the $\alpha$-particle energy has been measured for a thick argon target. For $E_\alpha = 17\text{ MeV}$ the $^{43}\text{K}$ yield is equal to $2330\text{ kBq/μA·h}$, and the admixture of $^{42}\text{K}$ formed by the reaction $^{40}\text{Ar}(\alpha,\text{n})^{42}\text{K}$ amounts to 8-10%. A $^{42}\text{K}$ yield of $2220\text{ kBq/μA·h}$ has been obtained at $E_\alpha = 21\text{ MeV}$ in [2] for a similar gaseous target.

The $^{42}\text{K}$ and $^{43}\text{K}$ yields are measured in this paper as a function of the proton and deuteron energy for a thick calcium target. Samples of metallic calcium were irradiated in the deflected beam of the Physicopower Institute cyclotron (Obninsk). The $^{42}\text{K}$ and $^{43}\text{K}$ yields were measured for six values of the particle energy. When calcium is irradiated by protons and deuterons, the radioisotopes $^{43},^{44}\text{Mg},^{42},^{43}\text{Sc}$ with half-lives from 3.89 h to 83.8 days are formed with an appreciable yield, which complicates the measurement of the activity of $^{42},^{43}\text{K}$ in the irradiated samples. Therefore, we radiochemically isolated $^{42},^{43}\text{K}$ from the irradiated samples, identified these isotopes from their $\gamma$-radiation and half-life, and measured their activity by the number of pulses in the photopeak of the selected $\gamma$-line. The following values of the $\gamma$-photon yield from [3] were used: $^{42}\text{K}$ (1525 keV; 17.9%) and $^{43}\text{K}$ (617.2 keV; 71.8%). The procedure for measurement of the activity of the isotopes and the integrated irradiation current of the samples is similar to that described in [1].

The measurement results for the yields are given in Fig. 1 and in Table 1. The errors in the values of the yields (15-16%) are caused mainly by systematic errors in measurements of the activity of $^{42},^{43}\text{K}$ and the integrated irradiation current of the samples as well as by the error in determination of the percentage of radiochemical isolation of $^{42},^{43}\text{K}$ from the irradiated samples.
Fig. 1. Yields of $^{42}$K and $^{43}$K upon irradiation of thick calcium targets by protons and deuterons. This paper: $\bullet$) Ca + p $\rightarrow ^{42}$K; $\circ$) Ca + p $\rightarrow ^{43}$K; $\Delta$) Ca + d $\rightarrow ^{42}$K; $\lambda$) Ca + d $\rightarrow ^{43}$K ($\pm$10 times); Ref. 5: $\square$) $^{44}$Ca (p 2p) $^{42}$K; $\square$) $^{43}$Ca (p 2p) $^{43}$K.

TABLE 1. Yields of $^{42}$K and $^{43}$K

<table>
<thead>
<tr>
<th>Radiosotope</th>
<th>Production reaction</th>
<th>Energy threshold of reaction, MeV</th>
<th>Content of original isotope, %</th>
<th>Particle energy, MeV</th>
<th>Yield, Bq/μA·h</th>
<th>Remark</th>
</tr>
</thead>
<tbody>
<tr>
<td>$^{42}$K</td>
<td>$^{44}$Ca (p 2p)</td>
<td>12.45</td>
<td>2.13</td>
<td>21.5</td>
<td>27±4</td>
<td>$a^+$</td>
</tr>
<tr>
<td>$^{43}$K</td>
<td>$^{44}$Ca (p 2p)</td>
<td>10.92</td>
<td>2.13</td>
<td>21.5</td>
<td>11.5±1.7</td>
<td>$b^+$</td>
</tr>
<tr>
<td></td>
<td>$^{44}$Ca (d 2p n)</td>
<td>15.05</td>
<td>2.13</td>
<td>21.5</td>
<td>11.8±1.8</td>
<td>$a$</td>
</tr>
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<td>$^{44}$Ca (d 2p n)</td>
<td>4.08</td>
<td>2.13</td>
<td>21.5</td>
<td>42±7</td>
<td>$b$</td>
</tr>
<tr>
<td></td>
<td>$^{44}$Ca (d 2p n)</td>
<td>14.14</td>
<td>2.13</td>
<td>21.5</td>
<td>470±70</td>
<td>$a$</td>
</tr>
</tbody>
</table>

*Reactions of the type (p $^3$He) and (d $^3$He) are not given in view of their relatively low cross sections (for example, see [7]).

$^*$Data of this paper (a).

$^b$Estimate of the yield from the cross section of the (p 2p) reaction with $E_p = 21.5$ MeV (b).

One paper [5] has been published in all in which the cross sections of $^{42}$Ca(p 2p)$^{42}$K and $^{44}$Ca(p 2p)$^{43}$K reactions, in which $^{42}$, $^{43}$K is formed from calcium with $E_p = 21.5$ MeV, are measured: 7 ± 1 and 2 ± 0.3 mb, respectively ($1b = 10^{-28}$ m$^2$). The effective thresholds of these reactions estimated from the formula given in [6] are approximately 16.5 and 18 MeV,