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Research Article

Synthesis of Silicon in the Interaction of Aluminum With a Quasi-Neutron and Estimation of the Contribution of the Aluminum Hydride Complex

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Abstract

Among the nuclear fusion reactions of new elements, the simplest reaction refers to the capture of a proton p by the nucleus of the original element ${}_ZX^A$ with the formation of the ${}_{Z+1}Y^{A+1}$ nucleus (Z and A are the charge and mass number of the element X). In the case of cold fusion, the occurrence of such a reaction is associated with the existence of quasi-neutron $(p + e)$ states in which the proton is "escorted" by the electron e: ${}_ZX^A + (p + e) \rightarrow {}_{Z+1}Y^{A+1} + e$. For example the synthesis of zinc from copper was established. It is important to note that the ratios of the proportions of synthesized isotopes in most cases should differ significantly from natural ratios, which would certainly confirm their artificial origin. The data of preliminary mass spectrometric measurements for the synthesis of zinc from copper, gallium from zinc, and rhenium from tungsten are consistent with this conclusion. However, for relatively heavy elements, the masses of daughter atoms with ${}_{Z+1}Y^{A+1}$ nuclei are difficult to distinguish from the masses of hydride complexes of parent atoms with ${}_ZX^A$ nuclei and hydrogen atoms H formed in the course of mass spectrometric measurements. In this regard, the problem of estimating the contributions of daughter atoms and hydride complexes is topical. The solution of this problem was carried out for the case of silicon synthesis from aluminum. In an air environment with water vapor, an electric arc was ignited between an aluminum anode and a tungsten cathode. Aluminum has one stable isotope ${}_{13}Al^{27}$; therefore, the synthesis of only one of the three stable silicon isotopes ${}_{14}Si^{28}$ was expected, which was observed in the mass spectrum of the powder formed on the anode surface (peak at ≈ 27.977 a.m.u.). The AlH complex corresponds to a peak at ≈ 27.989 a.m.u. This peak has a height approximately 2.5 times less than the height of the peak for the mass distribution of silicon atoms. Thus, the relatively low intensity for the mass distribution of the AlH complex suggests that it is the isotope ratios of the synthesized daughter nuclei that make the main contributions to the observed isotope mass ratios in the cases of parent atoms having several stable isotopes.

Keywords: Cold fusion, quasi-neutron, mass spectrum, aluminum, silicon, aluminum hydride

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Table 1. The expected difference between the mass ratios of synthesized isotopes (exp) and their ratios in nature (nat).

Z (X)	Z + 1 (Y)	Z, A_1, A_2	Z + 1, A^*_1, A^*_2	$f(A^*_2)/f(A^*_1)_{exp}$	$f(A^*_2)/f(A^*_1)_{nat}$
22 (Ti)	23 (V)	Ti, 49, 50	V, 50, 51	0,95749	399
29 (Cu)	30 (Zn)	Cu, 63, 65	Zn, 64, 66	0,446	0,56
30 (Zn)	31 (Ga)	Zn, 68, 70	Ga, 69, 71	0,03306	0,66367
74 (W)	75 (Re)	W, 184, 186	Re, 185, 187	0,92787	1,6738

1. Introduction

Among the nuclear fusion reactions of new elements, the simplest reaction refers to the capture of a proton p by the nucleus of the original element ${}_ZX^A$ with the formation of the ${}_{Z+1}Y^{A+1}$ nucleus (Z and A are the charge and mass number of the element X). In the case of cold fusion, the occurrence of such a reaction is associated with the existence of quasi-neutron ($p + e$) states [1], [2] in which the proton is "escorted" by the electron e:

$$ {}_ZX^A + (p + e) \to {}_{Z+1}Y^{A+1} + e. \tag{1}$$

The essence of the quasineutron concept is simple. As is known, there is the stationary bound state of the electron and proton in the form of a hydrogen atom ($\sim 10^{-10}$ m in size). In the concept of quasi-neutrons, the existence of non-stationary states is allowed, when an electron "escorts" a proton, screening its positive charge. Additional remarks on quasi-neutron states are given in Section 4.

In experiments [3], the synthesis of zinc with the participation of copper was observed:

$$ {}_{29}Cu^{63} + (p + e) \to {}_{30}Zn^{64} + e, {}_{29}Cu^{65} + (p + e) \to {}_{30}Zn^{66} + e, \tag{2}$$

which is consistent with the concept of quasineutrons.

2. Expected Ratios of Synthesized Isotopes and a Problem of Estimating the Contributions of Daughter Atoms and Hydride Complexes

In this regard, the problem naturally arises of determining the ratios of the synthesized isotopes $f\ (A_2^*)$ / f $(A_1^*)_{\rm exp}$, which should be specified by the natural ratio of the initial isotopes $f\ (A_1)$ / f $(A_2)_{\rm nat}$. Here $A_{1,2}$ are the mass numbers of the initial isotopes, $A^*_{1,2} = A_{1,2} + 1$. As a result, the ratio of the synthesized isotopes may differ markedly from their natural ratio $f\ (A_2^*)/f\ (A_1^*)_{\rm nat}$, as follows from the data in Table 1.

The results [4] of mass spectrometry for the synthesized isotopes of zinc (with electrolysis of water using copper electrodes) and gallium (using zinc electrodes) are generally consistent with the expected results. The observed deviations from the expected values are due to the contribution of additional reactions other than proton capture.

Note that the ratio of the synthesized isotopes is always much closer to the expected value (exp) than to the natural value (nat), and the degree of similarity increases for small fractions of the synthesized powder.

For relatively heavy elements, the masses of daughter atoms with ${}_{Z+1}Y^{A+1}$ nuclei are difficult to distinguish from the masses of hydride complexes of parent atoms with ${}_ZX^A$ nuclei and hydrogen atoms H formed in the course of mass spectrometric measurements. In this regard, the problem of estimating the contributions of daughter atoms ${}_{Z+1}Y^{A+1}$ and hydride complexes ${}_ZX^A\ H$ is topical.

3. Experimental Results

The solution of this problem was carried out for the case of silicon synthesis from aluminum. Figure 1 shows a scheme of a simple experiment carried out at the Department of General Physics of the Ural Forest Engineering University.

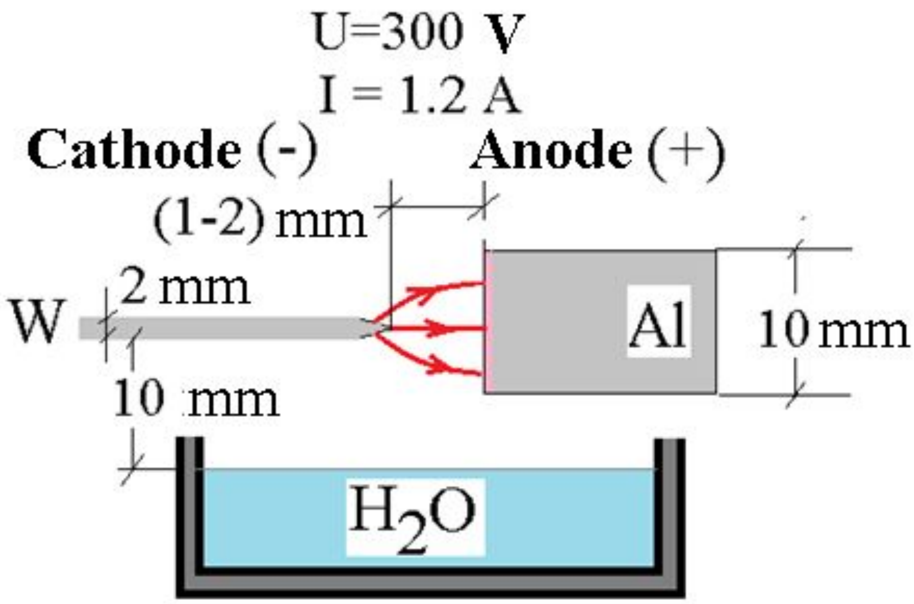

Figure 1. Experiment scheme: arc discharge in air. Conventionally, a thin surface layer of the aluminum anode is marked.

In an air environment with a high content of water vapor, an arc discharge was created between the tungsten cathode and the aluminum anode. At a typical potential difference U $\approx$ 300 V, the current I was $\approx$ 1.2 A. The geometric parameters are shown in the figure.

A small container of water led to an increase in the content of water vapor. The presence of water vapor should have promoted, in particular, the simplest nuclear reaction for the synthesis of rhenium isotopes Re - 185, 187, respectively, from tungsten isotopes W - 184, 186 during the capture of a proton escorted by an electron [5]. However, here we restrict ourselves to data on the synthesis of silicon and the possibility of separating Si-28 and aluminum hydride AlH, which are close in mass.

The analysis of the mass spectrum was carried out at the Department of Technical Physics of the Institute of Physics and Technology of the Ural Federal University. We used a Phi Trift V nano TOF time-of-flight secondary ion mass spectrometer (see Fig. 2) with a resolution R = m / Δm $\leq 10^4$ and a sensitivity up to 10^7 at/cm^2 (10 ppb).

It is clear that for reliable detection of silicon synthesis, it is expedient to use initial aluminum samples with a low silicon content. Then we can hope that the amount of synthesized silicon will exceed its initial content. The mass spectrum of the original aluminum sample in the actual region near 28 a.m.u is shown in Figure 3. The large peak in Figure 3 corresponds to aluminum hydride AlH, the region to the left of the peak may contain a contribution from a small amount of Si-28.

Aluminum has one stable isotope $_{13}Al^{27}$; therefore, the synthesis of only one of the three stable silicon isotopes $_{14}Si^{28}$ was expected. Figure 4 shows the result for $_{14}Si^{\ 28}$ which was observed in the mass spectrum of the powder formed on the anode surface (peak at $\approx$ 27.977 a.m.u.). You can also see a small peak for *AlH* ($\approx$ 27.989 a.m.u.).

A comparison of Figures 4 and 3 unambiguously indicates the increase in the number of silicon isotope $_{14}\mathrm{Si}^{\ 28}$ during an arc discharge in the presence of water vapor. Aluminum hydride peak has a height approximately 2.5 times

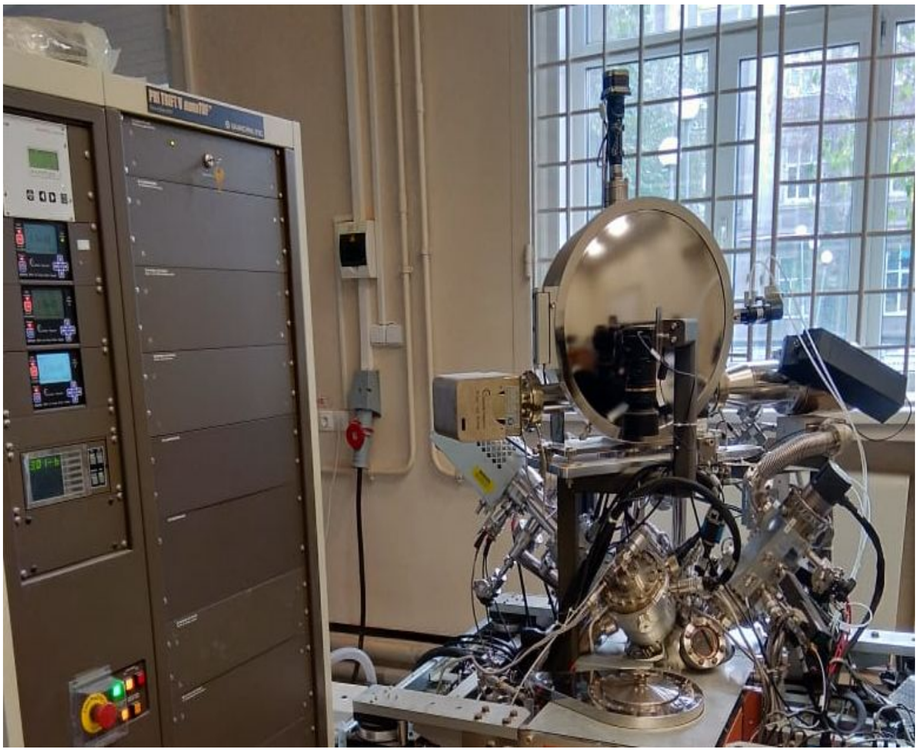

Figure 2. General view of the mass spectrometer.

less than the height of the peak for the mass distribution of silicon atoms. Thus, the relatively low intensity for the mass distribution of the *AlH* complex suggests that it is the isotope ratios of the synthesized daughter nuclei that make the main contributions to the observed isotope mass ratios in the cases of parent atoms having several stable isotopes. The results obtained indirectly testify in favor of the concept of quasi-neutron states in the implementation of cold fusion of nuclei in reactions (1).

Note that the appearance of the $_{14}Si^{28}$ isotope can give rise to the $_{14}Si^{29}$ isotope, and the appearance of $_{14}Si^{29}$ can give rise to the $_{14}Si^{30}$ isotope. Indeed, the capture of a proton by the $_{14}Si^{28}$ isotope leads to the unstable $_{15}P^{29}$ isotope with a half-life of $\approx$4.1 s. Positron emission leads to $_{14}Si^{29}$. Similarly, the positron decay of the $_{15}P^{30}$ isotope (half-life $\approx$ 2.5 min) leads to $_{14}Si^{30}$. Direct fixation of the $_{14}Si^{29}$ isotope is prevented by the superposition of the $_{14}Si^{28}H$ silicon hydride peak, as can be expected from the data in Figs. 5.

It is clear that the mass of the $_{14}Si^{29}$ isotope corresponds to the value ($\approx$28.9765 a.m.u.) lying to the left of the $_{14}Si^{28}H$ peak ($\approx$28.9847 a.m.u.). However, silicon hydride does not interfere with the identification of the $_{14}Si^{30}$ isotope. The corresponding mass spectrum is shown in Figure 6.

4. Final Remarks

1. Note that the experimental results obtained in this work on increasing the content of the Si-28 isotope, as well as the observed synthesis of zinc and gallium isotopes [3], [4], are consistent with the concept of quasi-neutrons.

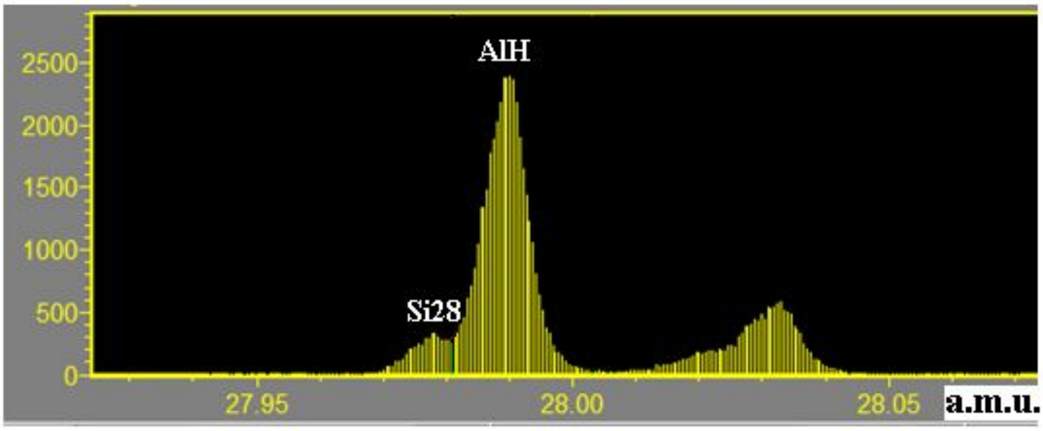

Figure 3. Mass spectrum of the initial aluminum sample in the vicinity of 28 amu. A small peak is close to the mass of the Si28 isotope (≈27.9769 amu).

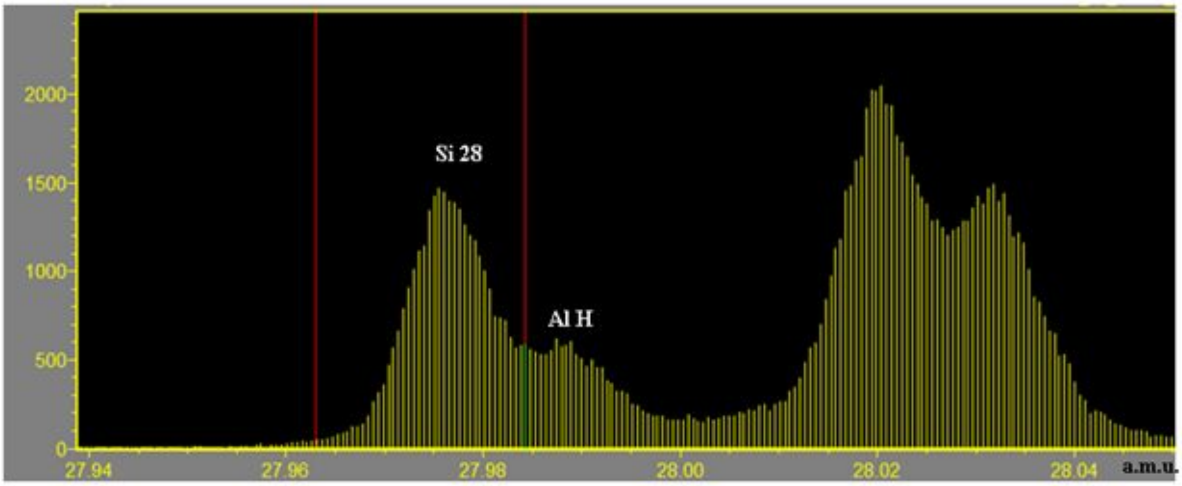

Figure 4. Mass spectrum showing the differentiation of silicon isotope Si - 28 (27.97693 a.m.u.) from aluminum hydride AlH (27.98936 amu).

2. According to the authors, the following additional arguments can be given in favor of the existence of quasi-neutron states:

i) The well-known quantum mechanical solution for the hydrogen atom (detailed, for example, in [6]) demonstrates that the probability of finding an electron is nonzero not only on atomic but also on nuclear scales.

ii) The penetration of electrons to nuclear scales is explicitly taken into account when calculating the isomer shift in the Mössbauer effect [7] and has been reliably confirmed experimentally.

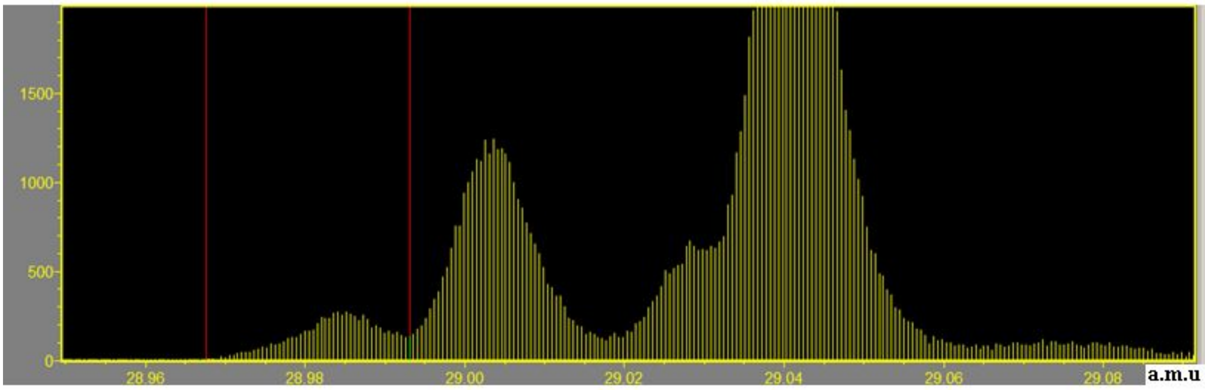

Figure 5. Mass spectrum showing the silicon гидрид $_{14}Si\ ^{28}H$ ((≈28.9847 a.m.u.).

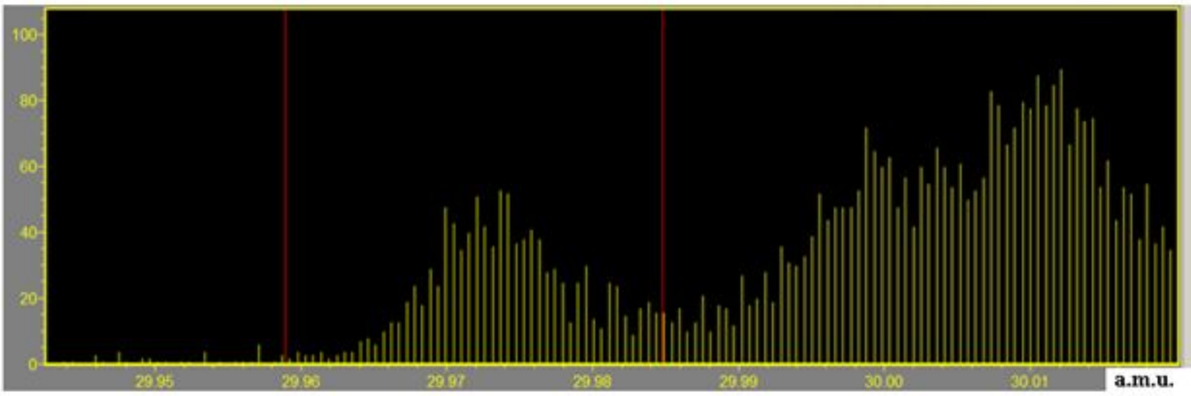

Figure 6. Mass spectrum showing the silicon isotope Si - 30 (29.97377 a.m.u.).

iii) The phenomenon of electron capture by a nucleus is also well known. This capture is associated with a weak interaction, the radius of which is about 10^{-18} m.

3. Therefore, it is natural to assume that there are states in which the electron "accompanies" the proton until the moment the proton is captured by the nucleus (during the exchange of pions according to the Yukawa mechanism).

4. It is appropriate to note that the data from modeling (by the molecular dynamics method) of the states of hydrogen atoms in a flow of free electrons in metals testify in favor of the concept of quasi-neutrons. Indeed, according to [8], there are non-stationary states in which electrons move around protons (or deuterons) in varying orbits up to $10^{-11} - 10^{-12}$ cm in size.

5. Of course, it is expedient to continue both experimental and theoretical studies on the topic of quasi-neutron states.

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