

The Detection of K-Ca Transmutation in the Mixture of K and Hydride Chemicals

LU Gong-xuan , ZHANG Xu-qiang , ZHEN Wen-long

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The Detection of K-Ca Transmutation in the Mixture of K and Hydride Chemicals

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Abstract: Here, we report the transmutation of K-Ca under the negative hydrogen condition (NaBH<sub>4</sub>, LiBH<sub>4</sub> and NH<sub>3</sub>BH<sub>3</sub>) at room temperature. In all reaction systems, the amount of K<sup>+</sup> and Ca<sup>2+</sup> concentrations were monitored by inductive coupled plasma optical emission spectroscopy (ICP-OES) and inductive coupled plasma mass spectrometry (ICP-MS) techniques. The ICP-OES test results showed that K<sup>+</sup> concentration was gradually decreasing, while the Ca<sup>2+</sup> concentration was gradually increasing. In addition, by comparing the K and Ca concentrations and their isotopes from the ICP-MS results, we found the increase of <sup>40</sup>Ca concentration accompanied by the increasing concentration of <sup>41</sup>K in the presence of hydride under our "reaction" conditions, which implying <sup>40</sup>Ca formation correlated to <sup>41</sup>K.

Key words: [K-Ca transmutation](#) [negative hydrogen](#) [low energy nuclear reaction](#)

关于在钾与负氢混合物中钾钙嬗变的检测

吕功煊 , 张旭强 , 甄文龙

摘要: 报道了在室温下钾与负氢混合物中钾钙发生嬗变的现象, 负氢是由NaBH<sub>4</sub>、LiBH<sub>4</sub>和NH<sub>3</sub>BH<sub>3</sub>提供的.实验中的钾和钙的浓度分别用诱导耦合等离子发射光谱法 (ICP-OES) 和诱导耦合等离子质谱法 (ICP-MS) 进行检测.ICP-OES结果表明随着混合物中钾浓度的降低伴随着钙的浓度增加.此外ICP-MS结果还表明<sup>40</sup>Ca浓度的增加伴随着<sup>41</sup>K浓度的增加, 可能表明在负氢存在的条件下混合物中<sup>40</sup>Ca的生成与<sup>41</sup>K物种有关.

关键词: [钾钙嬗变](#) [负氢化合物](#) [低能核反应](#)

It is well accepted that the elements in the Earth are produced by nuclear reactions in the stars in universe and segregated in the Earth. In the mean time, some element atoms can convert into other atoms via radioactive decay, such as U to Pd, by which we know the age of our Earth. One element or its isotope can also be converted into another element or corresponding isotope by natural nuclear reaction<sup>[1-3]</sup>. For example, the radionuclides <sup>14</sup>C in Earth's atmosphere is formed by constantly bombing by the high energy cosmic rays and the most of <sup>40</sup>Ar comes from the decay of <sup>40</sup>K in the air. The natural transmutation of radioactive elements (such as plutonium and uranium) can yield other radioactive elements or isotopes, some are dangerous and harmful to human beings due to their strong radioactive emission<sup>[4-6]</sup>.

By bombing the target elements with high energy particle in accelerators or Tokamak, one element can be converted into another element, which is called artificial transmutation<sup>[2, 7]</sup>. The first artificial transmutation from N into O was done by Rutherford in 1919, who used α particle bomb nitrogen atoms to produce <sup>17</sup>O, known as <sup>14</sup>N + α → <sup>17</sup>O + p<sup>[2, 4-6]</sup>. John Cockcroft and Ernest Walton fulfilled an artificial nuclear reaction by bombing<sup>7</sup>Li with accelerated protons to split the Li nucleus into two α particles in 1932, known as "splitting the atom"<sup>[8]</sup>. Otto Hahn et al. discovered that the artificial uranium fission in 1938<sup>[9-11]</sup>. From 1991 to 1997 in the Laboratori Nazionali del Gran Sasso, Ga (gallium trichloride-hydrochloric acid solution as the target) transmutation into Ge through a neutrino-induced nuclear reaction was reported, via reaction: ν<sub>e</sub> + <sup>71</sup>Ga → <sup>71</sup>Ge + e<sup>-</sup><sup>[12-13]</sup>. Although these transmutation processes require high energy and high-cost equipment, the artificial nuclear transmutation has been considered as a possible way to convert the radioactive waste to less hazardous nuclear elements via accelerator<sup>[4, 7]</sup>.

Surprisingly, many experiments reported that element transmutation could be initiated under much lower energy level through metabolism processes of vegetal and animal organisms<sup>[14-21]</sup>. Some living organisms exhibit capability to transmute one element into another under very mild conditions. For example, Kervran et al. reported potassium and calcium contents changed during the growth of 840 seeds and 403 sprouts, their results indicated potassium might transmute into calcium during seeds growing, which could be represented in formula: <sup>39</sup>K + <sup>1</sup>p → <sup>40</sup>Ca + ΔE<sup>[15-19]</sup>. Some other elemental transmutations were also reported, such as sodium to magnesium (<sup>23</sup>Na + n → <sup>24</sup>Na<sup>+</sup> → <sup>24</sup>Mg+e<sup>-</sup>+ ν<sub>e</sub><sup>+</sup>) and manganese to iron (<sup>55</sup>Mn + n → <sup>56</sup>Mn<sup>+</sup> → <sup>56</sup>Fe + e<sup>-</sup>+ ν<sub>e</sub><sup>+</sup>)<sup>[20]</sup>. It was found that bio-transmutations were associated with ATP hydrolysis processes catalyzed by ATPase in biological bodies<sup>[21]</sup>. It is suggest that the elemental transmutation is essential to maintain a balance of certain elements in the biological bodies, which is critical to organism growth.

Most recently, we found such a low energy nuclear reaction could be achieved under normal conditions. Experimental results indicated that small amount of deuterium and helium can be produced during photocatalytic hydrogen evolution process from water catalyzed by Pt-graphene sensitized with Br-dye under visible light irradiation<sup>[3]</sup>. Similarly, helium 3 can be formed during photocatalytic hydrogen generation over CdS semiconductor dispersion under visible light irradiation<sup>[7]</sup>. In addition, we found potassium could be transmuted into calcium during

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ICP-OES measurement is conducted to monitor the concentration variation of elements in the reaction mixture to verify the element transmutation in the presence of hydride, and the corresponding results are given in [Fig. 1a](#). For the  $\text{NaBH}_4$  case, the  $\text{Ca}^{2+}$  concentrations in the  $\text{NaBH}_4+\text{KCl}$  mixture are  $0.131\pm0.006$ ,  $0.069\pm0.008$ ,  $0.258\pm0.012$  and  $0.427\pm0.013$  ppm, under the reaction temperature after 2 h reaction at 25, 50 and 75 °C, respectively. Distinctly, the  $\text{Ca}^{2+}$  concentration of the  $\text{NaBH}_4+\text{KCl}$  system gradually increases and are strongly dependent on the reaction temperature. It needs to be pointed out that there is no additional calcium source in these initial reaction mixtures. The ICP-OES measurements for every datum are repeated for three times and the average value is presented. [Fig. 1a](#) also displays the change of  $\text{K}^+$  concentration with the increase of reaction temperature. The concentration of K decreased with the reaction operation.

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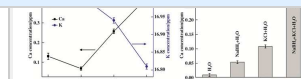
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25, 50 and 75 °C after reaction 2 h. 100 mL aqueous solution of KCl ( $4.115 \times 10^{-5}$  mol) and NaBH<sub>4</sub> (0.025 mol); (b) Ca<sup>2+</sup> concentration of the H<sub>2</sub>O, NaBH<sub>4</sub>, KCl, and NaBH<sub>4</sub>+KCl system at 50 °C after reaction 2 h.

To avoid misunderstanding of the results, we double checked the initial Ca concentration in Milli-Q H<sub>2</sub>O, NaBH<sub>4</sub> and KCl solutions by ICP-OES (pre-heated to 50 °C and kept pH=7). As shown in Fig. 1b, the Ca<sup>2+</sup> concentration in Milli-Q H<sub>2</sub>O is only  $0.010 \pm 0.005$  ppm. For the NaBH<sub>4</sub> and KCl aqueous solution, the Ca<sup>2+</sup> concentrations are  $0.053 \pm 0.005$  and  $0.108 \pm 0.006$  ppm, respectively. However, for the NaBH<sub>4</sub>+KCl reaction mixture, the Ca<sup>2+</sup> concentration obviously increase to  $0.258 \pm 0.012$  ppm. It is doubtless that the excess Ca in the mixture originated from the reaction of NaBH<sub>4</sub> and KCl.

To further study the K-Ca transmutation reaction, the cyclic experiments was done and the results were presented in Fig. 2. The concentration of Ca<sup>2+</sup> ions increases continuously when fresh NaBH<sub>4</sub> is introduced in the reaction mixture. After four cycles of NaBH<sub>4</sub> addition, the concentration of Ca<sup>2+</sup> reached  $0.356 \pm 0.008$  ppm. The ICP-OES data obvious confirmed that the concentration of Ca<sup>2+</sup> increases with the reaction time and the amount of NaBH<sub>4</sub> in mixture. The final Ca<sup>2+</sup> concentration increased up to 0.356 ppm after the four cycles. Although there is fluctuation of measured Ca concentration, the increase tendency of calcium is very obvious during reaction.

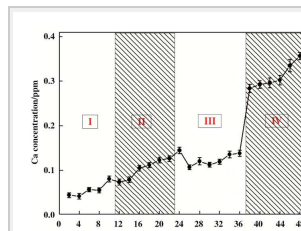


Fig.2 Cyclic experiment of NaBH<sub>4</sub>+KCl system at 25 °C, ( I ) First cycle, [NaBH<sub>4</sub>]: 0. 025 mol; [K<sup>+</sup>]:  $4.115 \times 10^{-5}$  mol; (II) addition of fresh NaBH<sub>4</sub> (0.025 mol); (III) third repeat; (IV) fourth repeat.

These are exotic phenomena that the increase of calcium concentration in NaBH<sub>4</sub>+KCl reaction mixture. Given that the reaction system is conducted in well sealed container which could prevent any exogenous contaminate, there is almost no choice but to believe that some substance in the reactive mixture might be converted to Ca element. Considering previous bio-transmutation research mentioned in introduction section ( $^{39}\text{K} + ^1\text{p} = ^{40}\text{Ca} + \Delta E$ ) and based on the above experimental results, a feasible way is the potassium element transmutation into calcium via H<sup>+</sup> LENR in the NaBH<sub>4</sub>+KCl system under a mild condition<sup>[15-19]</sup>.

In order to further prove above suggestion of this potential transmutation from potassium to calcium via H<sup>+</sup> LENR, comparative experiments are carried out by substituting NaBH<sub>4</sub> with LiBH<sub>4</sub> in the reaction mixture. Comparative experiments are repeated for several times, and their ICP-OES analysis results are presented in Fig. 3. The results indicated the concentration of Ca<sup>2+</sup> ions increased continuously in the LiBH<sub>4</sub>+KCl system. Correspondingly, the content of potassium decrease in the same system. Those results provide evidence that the increase of calcium concentration in the reaction mixture is closely related to the presence of H<sup>+</sup>, namely, indicating elemental transmutation from potassium to calcium.

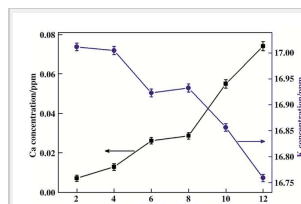


Fig.3 Ca<sup>2+</sup> and K<sup>+</sup> concentration of LiBH<sub>4</sub>+KCl system at various time are detected by ICP-OES at 0 °C after reaction 2 h. 100 mL aqueous solution of KCl ( $4.115 \times 10^{-5}$  mol) and LiBH<sub>4</sub> (0.025 mol).

Moreover, we use ICP-MS to detect the change of corresponding elemental isotope in the NH<sub>3</sub>BH<sub>3</sub>+KCl+RuCl<sub>3</sub>+Ca(NO<sub>3</sub>)<sub>2</sub> mixture. To verify the accuracy and credibility of ICP-MS results, other elements and their isotopes were simultaneously measured, such as Mo, because there was no Mo in the mixture. Mo, here, was used as a probe element to check if the reaction was contaminated. Fig. 4a shows the ICP-MS results of the measured concentrations of Mo isotope in the different NH<sub>3</sub>BH<sub>3</sub> loading (1#, 358.5 mg; 2#, 717.0 mg; 3#, 1075.5 mg), as well as in other used chemical reagents, KCl, RuCl<sub>3</sub> and Ca(NO<sub>3</sub>)<sub>2</sub>. The results indicated that the isotopes content of Mo are very low, and the ratio between different isotopes of Mo remains almost unchanged in the reaction mixture (Fig. 4b). This mean that the ICP-MS can be used to detect and track the minor change of elemental isotopes.

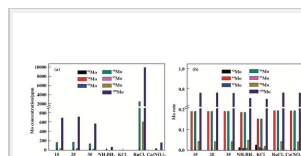


Fig.4 (a) Mo isotope concentration of NH<sub>3</sub>BH<sub>3</sub>+KCl+RuCl<sub>3</sub>+Ca(NO<sub>3</sub>)<sub>2</sub> system with different NH<sub>3</sub>BH<sub>3</sub> content 1# (358.5 mg), 2# (717.0 mg) and 3# (1075.5 mg), and the isotope content in NH<sub>3</sub>BH<sub>3</sub>, KCl, RuCl<sub>3</sub> and Ca(NO<sub>3</sub>)<sub>2</sub> are detected by ICP-MS. (b) the corresponding isotope ratio in their respective systems.

Fig. 5a and Fig. 6a show the ICP-MS results of K and Ca isotope concentration in NH<sub>3</sub>BH<sub>3</sub>+KCl+RuCl<sub>3</sub>+Ca(NO<sub>3</sub>)<sub>2</sub> mixture with different NH<sub>3</sub>BH<sub>3</sub> loading. We can find that the K isotope ratio, such as  $^{39}\text{K}$ ,  $^{40}\text{K}$  and  $^{41}\text{K}$ , have obvious changes after the reaction, as shown in Fig. 5b. In particular, the amount of isotope  $^{41}\text{K}$  gradually increase with the increase of negative hydrogen loading from NH<sub>3</sub>BH<sub>3</sub>. In addition, we can clearly see that the isotopes of Ca exhibits similar changes in Fig. 6b. Compared with isotope  $^{42}\text{Ca}$ ,  $^{43}\text{Ca}$ ,  $^{44}\text{Ca}$ ,  $^{46}\text{Ca}$  and  $^{48}\text{Ca}$ , the amount of isotope  $^{40}\text{Ca}$  also increase with the increase of NH<sub>3</sub>BH<sub>3</sub>. The variation of  $^{41}\text{K}$  and  $^{40}\text{Ca}$  is obviously not due to the experimental error, as shown in Fig. 7a and 7b.

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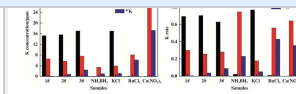
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NH<sub>3</sub>BH<sub>3</sub> content 1# (358.5 mg), 2# (717.0 mg) and 3# (1075.5 mg), and the isotope content in NH<sub>3</sub>BH<sub>3</sub>, KCl, RuCl<sub>3</sub> and Ca(NO<sub>3</sub>)<sub>2</sub> are detected by ICP-MS. (b) the corresponding K isotope ratio.

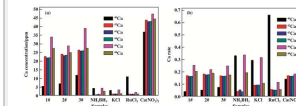


Fig.6 (a) Ca isotope concentration of NH<sub>3</sub>BH<sub>3</sub>+KCl+RuCl<sub>3</sub>+Ca(NO<sub>3</sub>)<sub>2</sub> system with different NH<sub>3</sub>BH<sub>3</sub> content 1# (358.5 mg), 2# (717.0 mg) and 3# (1075.5 mg), and the isotope content in NH<sub>3</sub>BH<sub>3</sub>, KCl, RuCl<sub>3</sub> and Ca(NO<sub>3</sub>)<sub>2</sub> are detected by ICP-MS. (b) the corresponding Ca isotope ratio.

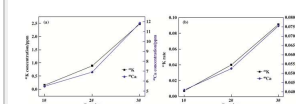
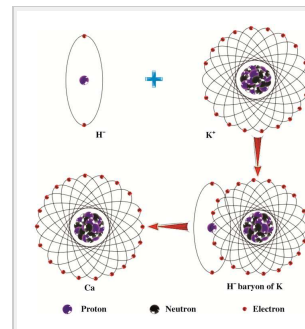
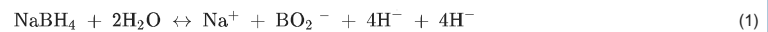


Fig.7 (a) <sup>41</sup>K and <sup>40</sup>Ca isotope concentration of NH<sub>3</sub>BH<sub>3</sub>+KCl+RuCl<sub>3</sub>+Ca(NO<sub>3</sub>)<sub>2</sub> system with different NH<sub>3</sub>BH<sub>3</sub> content 1# (358.5 mg), 2# (717.0 mg) and 3# (1075.5 mg) are detected by ICP-MS. (b) the corresponding <sup>41</sup>K and <sup>40</sup>Ca isotope ratio.

These surprising experimental results are difficult to interpret and even beyond our existing theoretical knowledge. However, based on the above experimental results, a plausible transmutation process might be shown in Scheme 1. Negative hydrogen compound molecule (such as NaBH<sub>4</sub>) is easy to hydrolyze and produce H<sup>-</sup> ions, which is a complex substance composed of a hydrogen atom that weakly binds two electrons and can be seen as a baryon<sup>[23]</sup>. Due to the strong electrostatic attraction, K<sup>+</sup> ions that come from KCl could randomly capture a H<sup>-</sup> in a manner we still not clearly understand, probably by nucleus-electron-nucleus interaction, forming H<sup>-</sup> baryon-potassium intermediate, and this intermediate(s) could decay to <sup>41</sup>K and <sup>40</sup>Ca:



Scheme 1 Scheme diagram of a typical K-Ca transmutation process

Transmutation process could mainly be attributed to the formation of H<sup>-</sup>-K intermediate<sup>[22]</sup>. The H<sup>-</sup> baryon, like electrons in ordinary atoms, approaching the potassium nucleus. According to the Bohr Theory, the atomic orbital radius ( $r_n$ ) is inversely proportional to the mass of H<sup>-</sup> baryon:

$$\begin{aligned} r_n &\approx \frac{h^2}{8\pi^2 z e^2 m} [3n^2 - l(l+1)] \\ &\approx \frac{m_e}{m} \frac{[3n^2 - l(l+1)]}{2z} a_0 \end{aligned} \quad (3)$$

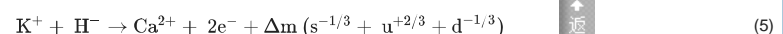
where  $h$  is Plank constant ( $6.6262 \times 10^{-34}$  J s),  $n$  is main quantum number,  $l$  is angular quantum number,  $z$  is atomic number,  $e$  is charge of negative ions ( $1.6022 \times 10^{-19}$  C),  $m_e$  is electronic mass ( $9.1096 \times 10^{-31}$  kg),  $m$  is the mass of negative ions in the atom ( $1.6811 \times 10^{-27}$  kg),  $a_0$  is the Bohr radius of H atom ( $0.5292 \times 10^{-10}$  m)<sup>[24-25]</sup>. For the H<sup>-</sup>-K, if the outer valence electron of K is occupied by H<sup>-</sup> baryon, and the possible particle radius  $r$  is about  $3.5216 \times 10^{-14}$  m, which is only 1/1836 of the normal K atom. This means that the radius of H<sup>-</sup>-K is in the same order of magnitude as the radius of the nucleus. So that the H<sup>-</sup> baryon has a higher probability to enter the K nucleus.

The energy levels of H<sup>-</sup>-K have also changed greatly. From the formula (4), we find that the H<sup>-</sup> baryon does not move on the original electron orbit, but has its own set of energy level orbits. These orbital energy levels ( $E_n$ ) can be determined by the following formula:

$$E_n = -\frac{mc^2}{2} \left( \frac{\alpha z}{n} \right)^2 \left[ 1 + \left( \frac{\alpha z}{n} \right)^2 \left( \frac{n}{j+1/2} - \frac{3}{4} \right) - \dots \right] \quad (4)$$

where  $c$  and  $\alpha$  are the light speed and fine-structure constant;  $j$  is total angular momentum quantum number of negative particles. The meaning of other symbols is the same as that of the former formula. For this particular structure,  $E_n$  depends on the H<sup>-</sup> baryon mass. Compared to the normal electronic transitions, H<sup>-</sup> baryon released energy is higher.

As for the mass difference before and after reaction in formula (4), it should corresponds some energy variation during this reaction. According to the mass-energy equation,  $E = mc^2$ , the mass difference may correlate energy releasing or new matter formation, for example, some quarks.



A lot of research facts show that calcium is an important element for human body, constituting the bones and teeth and helping heart and other muscles do their work normally<sup>[26-30]</sup>. Low calcium intake could lead to fragile bones, high blood pressure, and certain types of cancer. Actually, H<sup>-</sup> can act as antioxidant by selectively reducing cytotoxic oxygen radicals<sup>[30]</sup>. It could be supposed that there might be hydrogen which existing as



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