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Study of Specific Biological Product for Voltage Generation in Electrochemical Voltaic Device

by

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Abstract

We have previously carried out experiments with small electrochemical voltaic devices containing biological product (raw silk) at both places near a nuclear reactor and under natural environment. The experimental results indicated that the output signal of the device near the reactor was clearly larger than that of environmental one. The output signal was understood to be produced by effect of biological product on environmental neutrinos, and was supposed to be increased through a function of certain field near the nuclear reactor. Raw silk is composed of two different layers of protein materials, internal fibroin and surface sericin. We attempted to study the contributions of two protein materials to the signal generation. Difference of experimental results between raw silk (fibroin plus sericin) and fibroin only samples indicated that sericin is the reaction-assisting material for signal generation. In addition, we carried out quantitative analysis of eluted ions into solution in the voltaic device. Almost all ions were found to be eluted from the surface sericin in about two days. This effect is supposed to be related an initial peak of the output signal behavior.

Keywords: Neutrino, Weak interaction, Electrochemistry, Voltaic device, Biological product

1. Introduction

Neutrinos are neutral particles which have extremely small interaction cross-sections, for instance, of the order of 10^{-44} cm^2 (E/MeV)[1]. Interactions of neutrinos are explained by electroweak theory in the standard model[2),3),4)], where quite massive bosons work in Vector (V) - Axial Vector (AV) type interaction through assumed Higgs field. The interaction cross section is formulated by massive-boson mediated momentum transfer process. It is noted that the weak charge (hypercharge) is set at basically the same value as the electric charge *e* in the electromagnetic interaction.

Some of the authors have previously carried out experiments with small electrochemical voltaic devices containing biological product (raw silk) at both places near a nuclear reactor and under natural environment.[5] The experimental results indicated that the output signal of the device near the

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reactor was clearly larger than that of environmental one. Neutrino has the hypercharge with the magnitude of *e*. If a reaction channel opens in a certain condition without use of massive-boson mediated momentum transfer, the reaction is supposed to readily take place because of the considerable magnitude of *e*. In such case, it may be possible to consider that the output signal of voltaic device was produced by effect of biological product on environmental neutrinos, and it was increased through a function of certain field near the nuclear reactor.

Raw silk is composed of two different layers of protein materials, interior fibroin and surface sericin layer. In this study, we attempted to reveal the contributions of two proteins of fibroin and sericin to the output signal. In addition, we carried out quantitative analysis of ions in solution eluted from raw silk to understand the output signal behavior.

2. Voltaic device by use of biological product

Schematic view of the electrochemical voltaic device is shown in **Fig. 1**. A gold (purity 99.99%) anode, and a glassy carbon (purity 99.5%) cathode are set at a distance of 1 cm in double-deionized purified water of 50 g in the Teflon (polytetrafluoroethylene, PTFE) container. Biological product of raw silk in total amount of 1 g is placed around the anode. Voltaic devices in an incubator are presented in **Fig. 2**. The incubator keeps the temperature constant at 27 °C. The experiment was carried out at position of 18 m from ATR reactor core[5]. As for the natural environmental measurement, our group has experiences of long-term experiments[6]: The output signal increased through over a year, and reached 90 nA after1.5 years. The long-term experimental result suggests that the output signal was generated by continuous deposition of some energy from environmental situation. Raw silk consists of mainly two protein materials, interior fibroin and surface sericin. Fibroin is a fiber, and sericin is a glue in the outer surface layer. Sericin can be removed by boiling alkaline solution.

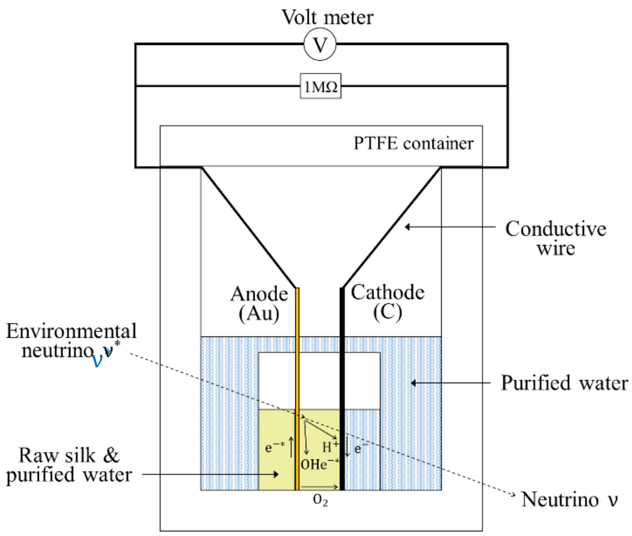

Fig. 1. Illustration of the low-energy environmental neutrino detector. Raw silk around an anode generates assisting field. When ν^* enters into this region, it is supposed to dissociate water molecule into $\mathrm{OHe}^{-*} + \mathrm{H}^{+}$.

Fig. 2. Picture of the detectors in an incubator.

The output signal generation[5)] is unexplainable with the standard small cross-sections by the established weak interaction formulation. To explain the results, we consider that some fraction of environmental neutrinos is in a certain excited state of ν^*. It is assumed that the total angular momentum z-component of ν^* is -1/2, while the spin is resultantly zero, i.e. boson. The usual neutrino mass is understood to be created by Higgs field. We consider that the Higgs-like field (called $B_{\mathrm{H}}^{\mathrm{ext}}$ hereafter) is created near nuclear reactors. When the bosonic environmental neutrino ν^* enters into a region of intense $B_{\mathrm{H}}^{\mathrm{ext}}$, the field augments the mass of ν^*, and readily open reaction channel with water molecule as $\nu^* + \mathrm{H_2O} \rightarrow \nu + \mathrm{OHe^{-*}} + \mathrm{H^+}$, without process through heavy boson mediated momentum transfer. The measured output current near ATR is considered to be caused by the function of boson-like $\mathrm{e^{-*}}$ through $B_{\mathrm{H}}^{\mathrm{ext}}$ near the nuclear reactor. Raw silk may have the capability to generate $B_{\mathrm{H}}^{\mathrm{ext}}$ probably because of natural isotope such as potassium 40.

The signal generation of voltaic device may be based on the electrochemical reaction which is assisted by boson-like $\mathrm{e^{-*}}$. The supposition of voltage-generation mechanism is as follows. When ν^* encounters an external field $B_{\mathrm{H}}^{\mathrm{ext}}$ from raw silk, the field increases the mass and makes ν^* unstable, leading to dissociative ionization of water molecule as

$$\nu^* + \mathrm{H_2O} \rightarrow \nu + \mathrm{OHe^{-*}} + \mathrm{H^+}. \quad (1)$$

The spin-cancelled electron ($\mathrm{e^{-*}}$) in $\mathrm{OHe^{-*}}$ may avoid the recombination of $\mathrm{OHe^{-*}}$ and $\mathrm{H^+}$ by disturbing formation an electron pair in singlet for covalent bond between O and H. Boson-like $\mathrm{e^{-*}}$ is transported into an anode as

$$4\mathrm{OHe^{-*}} \rightarrow 2\mathrm{H_2O} + \mathrm{O_2} + 4\mathrm{e^{-*}}. \quad (2)$$

It is noted that the reaction without $\mathrm{e^{-*}}$ is endothermic. If the spin-cancelled electron ($\mathrm{e^{-*}}$) behaves like a boson following to Bose-Einstein statistics[7)], however, the Bose-Einstein feature of $\mathrm{e^{-*}}$ allows $\mathrm{e^{-*}}$ to jump in the state below the Fermi level in gold electrode. The normal positive ions $\mathrm{H^+}$ make the exothermal reaction around the cathode as

$$4\mathrm{H^+} + \mathrm{O_2} + 4\mathrm{e^-} \rightarrow 2\mathrm{H_2O}. \quad (3)$$

The output current may be generated by the sequence of Eqs. (1-3) assisted by the boson-like $\mathrm{e^{-*}}$ with Bose-Einstein statistics feature.

3. Experimental result for the voltaic device containing sericin-removed sample

To study contributions of two protein materials of fibroin and sericin in raw silk to the output signal generation, we carried out experiment using sericin-removed raw silk. Sericin is readily removed in boiling sodium carbonate solution. The process is as follows. The solvent was purified water of 100 g and the solute was sodium carbonate of 0.06 g. Raw silk of 0.5 g was put into the solution, and it was boiled for an hour at a temperature around 85 ℃. Removed sericin was typically 25 % of raw silk in weight, and remaining fibroin amounted to about 75 %. The boiled samples were cleaned by ultrasonic cleaner to take away the solute. Because boiling is necessary for sericin removal process, the effect of the heating itself on raw silk should be examined. For this purpose, other samples were prepared: they were placed inside a polyethylene bag in heated water for an hour at the same temperature.

We prepared three types of samples of normal raw silk, heated raw silk, and sericin-removed sample (fibroin). The experimental results for the voltaic device containing these samples are shown in **Fig. 3**. Six experimental data were averaged and they supplied the standard deviations. A slight decrease in the output signal was seen for heated sample, whereas the signal for sericin-removed one goes to zero nA. The smaller signal of heated one may be caused by malformation of protein, but the difference of output signal between heated and normal ones ranges within error bars. The experiment result indicated that sericin is the reaction-assisting material and plays an essential role in the output signal generation.

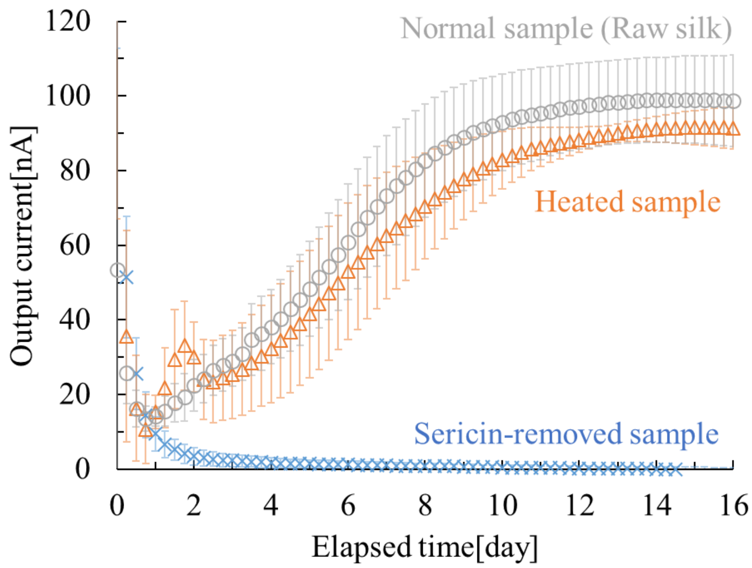

Fig. 3 Experimental results for the detectors containing three types of samples. Grey circular marks stand for normal raw silk, red triangular marks for heated one, and blue cross marks for sericin-removed one (fibroin). The output signals of the detector containing normal and heated ones are almost the same, whereas that for sericin-removed one goes to zero nA.

4. Quantitative analysis of ions in the detector

In addition to the above experiment, we made quantitative analysis of ions eluted from raw silk and sericin-removed samples. The former corresponds to ions eluted from surface sericin, and the latter from fibroin. We prepared seven samples for analysis. The analysis was carried out by using ion chromatography method. The samples, analyzed ions and concentrations are listed in **Table 1**. The time evolutions of ion elution are shown in **Fig. 4**, excepting those ions of Br^-, NO_3^-, NO_2^- and PO_4^{3-} that were below detectable limit. The results indicated that almost all ions were eluted from the surface of sericin in about two days. NH_4^+ only increases clearly after the second day, but this ion is known to be very stable and hard to make reaction in water. Some eluted ions are considered to make initial output signal peak by oxidation reaction by oxygen around the second day. The peaking phenomenon is seen in **Fig. 3 s**pecially for heated sample. The sericin removing process made use of sodium carbonate. Therefore, Na^+ eluted from sericin-removed sample is considered to be attributed to the remaining sodium in fibroin after this process.

Table 1. The samples, analyzed ions, and analyzed quantities. Samples (a) ~ (f) are raw silk-immersed purified water, whereas (g) is fibroin -immersed one. Raw silk of 1 g was immersed in water of 100 g for 0, 1, 2, 4, 8, or 16 days.

	(a)	(b)	(c)	(d)	(e)	(f)	(g)Sericin removed sample
Immersed time[day]	0	1	2	4	8	16	8
F^-[mg/L]	-	0.11	0.11	0.15	0.14	0.13	0.06
Cl^-[mg/L]	-	0.34	0.27	0.3	0.43	0.27	0.45
Br^-[mg/L]	-	-	-	-	-	-	-
NO_3^-[mg/L]	-	-	-	-	-	-	-
NO_2^-[mg/L]	-	-	-	-	-	-	-
SO_4^{2-}[mg/L]	-	8	7.8	11	12	12	0.33
PO_4^{3-}[mg/L]	-	-	-	-	-	-	-
Na^+[mg/L]	-	1	0.93	0.87	1	2	14
Mg^{2+}[mg/L]	-	1.6	1.6	2.9	3.8	3.3	-
Ca^{2+}[mg/L]	-	7.7	8.4	11	14	17	-
NH_4^+[mg/L]	-	8.3	9.3	19	32	43	0.23
K^+[mg/L]	-	0.96	0.89	1.9	1	1.2	0.06

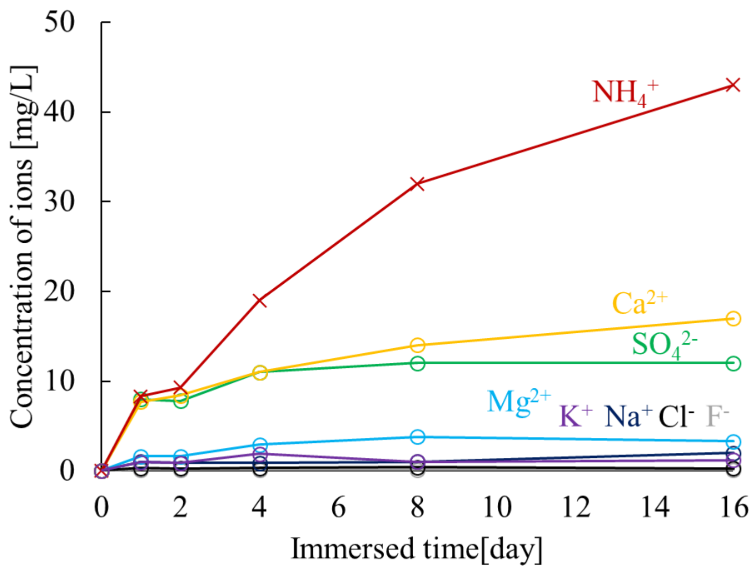

Fig. 4 The time evolutions of ion elution from the surface of raw silk. Excepting NH_4^+, almost all the ions were eluted from the surface of sericin in about two days.

5. Conclusion

We performed experiments with voltaic device to know the situation of electrochemical reaction. Measurement was made with samples of either raw silk or sericin-removed one. Difference between measurement results indicated that sericin is the essential material in raw silk for the signal generation. In order to infer the reason for electrochemical signal behavior, we carried out quantitative analysis of ions in the solution by ion chromatography method. The result confirmed almost all ions were eluted from the surface sericin in about two days. Some ions are considered to make initial peak of the output signal by oxidation reaction. The boson-like electron seems to work for generating the output signal with existence of sericin. It is suggested that the boson-like electron may promote biochemical reactions for synthesizing sericin itself.

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