Nuclear fusion reacted inside metals by intense sonoimplantation effect

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Abstract: Using intense ultrasonic cavitation effect, metals kept in heavy water were changed to nanometer-sized fine powders and simultaneously condensed a large amount of deuteriums for 1~2 days. Mass analyses of gases released from the remnant metal powders revealed existence of ^3He and ^4He which were produced by the deuterium nuclear fusion reacted inside the metals. On the other hand, simultaneously generated excess energy were recognized in only D_2O working liquid, using the working liquids of D_2O or H_2O -water in which immersed metal foils kept inside a sono-vessel.

Key words: Sonoimplantation; sono-powder; D-implantation; H-implantation; sono-solid fusion; sono-excess energy; sono-helium.

Introduction. Recently, we have investigated on the intense sonoimplantation of various gaseous atoms into metals.^{1,2)} The results showed that many metals (foils of Ti, Pd, Ag, Ta, Pt and Au) were changed into nanometer-sized powders (“sono-powders”) and simultaneously much D/H-atoms dissociated from the working liquids ($\text{D}_2\text{O}/\text{H}_2\text{O}$) were implanted into their “sono-powders”, respectively, and implanted-D atoms (“D-implantation”) were condensed inside the “sono-powders” with much stronger than the “H-implantation”. Such intense sonoimplantation effect caused the nuclear fusion to be reacted inside of metals (called shortly “sono-solid fusion”).

Experiment. The present experiment was carried out to show generation of the solid-state nuclear fusion (“solid fusion”) reacting inside of metals as follows: using a sonoimplantation system as shown in Fig. 1, sono-power of 300 watts with 19 kHz was supplied into the working liquid immersed the metallic foils (1~2 mm $\times$ 1~2 mm $\times$ 0.1 mm). In the first, the sono-vessel was evacuated to about 10^{-3} Torr and filled up with the degassed working liquid in which the metallic foils were originally set without the working gas. The metal foils were gradually broken into ultra-fine metal powders (“sono-powders”) whose minimum size was less than five nanometer in diameter only after 1~2 days as shown in Photo 1. Secondly, The mass analyses of the sono-pow-

ders were carried out with a quadrupole mass spectrometer system consisting of three parts: one sample vessel, two Ti-getter pumps, and two type (normal and high resolution) quadrupole mass spectrometers (QMS). The vertical scale of spectrum intensity of (10^{-11} [A]) corresponds to about (3×10^{11}) in ^4He . Hereafter the sono-powders of metal X in working liquids of D_2O , H_2O and mixed water are designated as X[D_2O], X[H_2O] and X[MIX], respectively, and X[*virgin*] indicates pure metal X foil immersed only in the working liquid for 20 hours without ultrasonic irradiation.

Fig. 2 demonstrates a typical example showing difference between the amounts of D and H atoms implanted into the Pd sono-powders, respectively. We have investigated that sono-implanted H and D atoms which released from the heated sono-powders form the molecules of hydrides/deuterides dispersed mostly in mass numbers of M1~M50 inside QMS. In these mass numbers, M1~M4 (first group) and M17~M22 (second group) are especially important to know each amount of the sono-implanted H/D atoms. These events were verified clearly using bar graphs of mass numbers (M1~M50) which were measured immediately after finished heating of the sample.^{1,2)}

In present experiment, similar parameters were measured simultaneously with heating of the sample as follows: Fig. 2 (A), (B), and (C) show relevant mass intensities as shown in first group (M2, M3, M4 in the upper side diagrams) and second group (M18, M19, M20, M22

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Fig. 1. Schematic diagram of ultrasonic irradiation system included "sono-vessel".

Photo 1. Electron micrograph of the sono-powder (Au) as the typical example.

in the lower side diagrams) in the sono-powders of Pd [virgin], Pd[H₂O] and Pd[D₂O], respectively. The similar behaviors were also displayed in other various metals as shown in Fig. 2 ① (Ti [D₂O]) and ⑤ (Ag [D₂O]) which were adopted here as the typical examples. As a result, difference between intensities of implanted D/H atoms in the sono-powders of Fig. 2 ③ (Pd [D₂O]) and ② (Pd [H₂O]) can be demonstrated by the ratio of spectrum intensity, (Pd[D₂O]/Pd[H₂O]), at the maximum point on each intensity curve in the relevant mass species such as

first group and/or second group as follows:

$$\text{First group: } F\left(\frac{D+DH+D_2}{H+DH+H_2}\right) = \frac{I(M2+M3+M4)}{I(M1+M3+M2)} \sim 10.$$

Second group:

$$F\left(\frac{DO^*+DHO+D_2O^*}{HO^*+DHO+H_2O}\right) = \frac{I(M18+M19+M20)}{I(M17+M19+M18)} \sim 1000.$$

Fig. 2. Chronological changes of QMS intensities of following relevant masses; M_2 , M_3 , M_4 in the upper side diagrams (first group) and M_{18} , M_{19} , M_{20} , M_{40} in the lower side diagrams (second group) in the sono-powders of Pd[Virgin], Pd[H₂O], Pd[D₂O], Ti[D₂O] and Ag[D₂O].

Fig. 3. Relation between sono-generated power and sono-current using sono-working liquids of [D₂O] and [H₂O]. [A] shows chronological change of each sono-generated power per unit current during formation of sono-powders (A:U[Pd], B:U[Ti], C:U[Au]) in both waters of [D₂O] and [H₂O], and [B] shows the chronological change of sono-currents in both waters.

Fig. 4. Relation between applied ionization voltage (V[V]) and spectrum intensity current (I[A]) (called “VI-relation”) detected by QMS using the relevant masses M3 (DH, H₃, ³He) and M4 (D₂, DH₂, ⁴He) in the sono-powders of Pd[D₂O], Ti[D₂O], Ag[D₂O], and Au[D₂O] as shown in middle and right side columns, (C₀, C₁; D₀, D₁; E₀, E₁ and F₀, F₁ show “Vi-effect” and also C₂, D₂, E₂, F₂ show normalized “Vi-effect”). In left side column, [A] and [B] show “VI-relations” of pure heliums (the almost same quantity of ³He and ⁴He) and the dilute heliums with 100 times quantity of hydrogen, respectively. (A₀ and B₀: Spectrum intensity, A₁ and B₁ called “Vi-effect”, A₂ and B₂ called normalized “Vi-effect” in the [A] and [B], respectively.) These diagrams are applied as standard diagrams for [C], [D], [E] and [F] in sono-powders mentioned above, and especially, “Vi-effect” of mixed gases of dilute heliums with H₂ display elements (DH, H₃, ³He) in mass M3 as shown in [B₁] and [B₂], and also using mixed (D₂ + H₂), elements (DH, H₃, ³He) and (D₂, DH₂, ⁴He) come in M3 and M4, respectively. Thus, these elements were formed in the case of “sono-powders” as shown in the middle and right side columns. In [B], because of dilution by excess hydrogens, only both DH and H₃ were formed in mass M3, while using excess deuteriums in stead of hydrogens both D₂ and DH₂ come in mass M4. Thus in the case of mixed (D₂ + H₂) gases, elements (DH, H₃, D₂, DH₂) can be made in both M3 and M4, respectively, and also these elements were formed in the case of “sono-powders” as shown in above middle and right side columns.

Fig. 5. Chronological changes of QMS spectrum-intensities of relevant mass M_4 (D_2 , ^4He) in the sono-powders of Pd[virgin], Pd[H_2O] and Pd[D_2O].

Here, DO^* and D_2O^* include (CD_3 , CD_2H_2) and (CD_4) reflecting in D-implantation, respectively, and HO^* includes (CH_3D) in H-implantation. It is concluded that comparison of implanted D and H atoms inside of metals should be using second group mass species. Consequently, the D-implantation is about a thousand times stronger than H-implantation in general.

The D-implantation effect makes deeply condensed deuteriums higher than the host metal density during a short period. This event is basically important characteristic to cause the “sono-solid fusion”. As a typical example in this case, reacted heliums (^3He , ^4He) are included in mass M3 (DH , H_3 and ^3He) and M4 (D_2 , DH_2 and ^4He), respectively, as shown in Fig. 2 (C), (D) and (E). Hereafter, helium (^3He , ^4He) generated in the “sono-powders” called simply “sono-helium”. On the other hand, simultaneously generated excess energy in the sono-powders were recognized in only D_2O -working liquid using the working liquids of D_2O or H_2O -water, then these events are called simply “sono-excess energy” as described in following section.

a) *Generation of “sono-excess energy”.* Fig. 3 shows excess energy generated inside the sono-vessel; [A] shows difference between “sono-generated energy” (sono-output/sono-current: $Q_{\text{out}}/I_{\text{imp}} (=Q_{\bullet})$ [watt/A])

during formation of sono-powders (A:U[Pd], B:U[Ti], C:U[Au]) using D_2O and H_2O -working liquids immersed the metal foils. [B] shows difference between sono-input currents (shortly “sono-currents”) changed with elapsed time [min] using the D_2O and H_2O working liquids, but these sono-currents were almost similar. Here, sono-generated energy ($Q_{\bullet}$) was introduced by temperature difference between outlet T_1 and inlet T_0 ($\Delta T = T_1 - T_0$) as shown in Fig. 1, but since a part of the sono-generated energy and/or “sono-excess energy” escapes as the loss from the sono-vessel to out-side through the “sono-vibrator”, actually measured energy should be considerably lowered, so that because it is difficult to detect the actual loss energy, the “sono-excess energy” ($\Delta Q_{\bullet}$ [watt/A]), therefore, is given by the difference between “sono-generated energies” ($Q_{\bullet}[\text{D}_2\text{O}]$; $Q_{\bullet}[\text{H}_2\text{O}]$) generated in working liquids (D_2O ; H_2O) as follows:

$$\Delta Q_{\bullet} = Q_{\bullet}[\text{D}_2\text{O}] - Q_{\bullet}[\text{H}_2\text{O}]$$

where, $Q_{\bullet} = (\text{sono-input energy} + \text{sono-excess energy} - \text{loss energy})/\text{sono-current}$.

It is concluded that using intense sonoimplantation effect for the many kinds of metal foils, both sono-excess energy and sono-helium (^3He , ^4He) generated simultaneously with formation of their nanometer-sized powder

(“sono-powder”) with extraordinary D-atoms or mixed H-atoms, so that we named “sono-solid fusion” for these events.

b) *Generation of “sono-helium”.* Fig. 4 shows relation between applied ionization voltage ($V[V]$) and spectrum intensity current ($I[A]$), (called simply “VI-relation”),³⁾ measuring relevant masses M3 and M4 in such sono-powders as Pd[D₂O], Ti[D₂O], Ag[D₂O] and Au[D₂O]. Here, the applied voltage is changed automatically from 17[V] to 40[V] through several times (for example; first: 30 [min] later, second: 1 [hr], third: 3 [hr],...) after finished heating of the sono-powders using normal type QMS, but another type of high resolution QMS is no changed to keep constant 70[V]. Fig. 4 [A] shows “VI-relation” in both M3 and M4 of almost equally mixed gases released from pure ³He and ⁴He gas tank. Fig. 4 [B] shows case of the mixed gases diluted by much hydrogens (~100 times) for helium gases of Fig. 4 [A], and such similar patterns of Fig. 4 [B] appear fluently in the sono-powders, as shown in Fig. 4 [C], [D], [E] and [F], respectively. In the Fig. 4 [A] and [B], A₀ and B₀ show normal “VI-relation”, and A₁, A₂, B₁ and B₂ demonstrate “VI-relations” indicating the intensity current changed per 2 voltage at each applied voltage. Hereafter, A₁ and B₁ diagrams called simply “Vi-effects” and A₂ and B₂ called normalized-“Vi-effect”.³⁾ Characteristic of both “Vi-effect” can contribute greatly to separate each other elements of DH, H₃ and ³He in M3, but it is not so easy in case of separating these elements using only high resolution spectrums. As a result, using “Vi-effect” and normalized-“Vi-effect”, existence and amount of each element such as ³He, ⁴He, ²²Ne, etc. can be clearly displayed, so that Fig. 4 shows existence and amounts of “sono-helium” (³He

and ⁴He) generated as reaction products in the “sono-solid fusion”.

Fig. 5 shows relation between amount of D₂ (sono-implanted D-atoms) and generation of “sono-helium ⁴He”, using spectrum-intensities of relevant mass M₄ generated in the sono-powders which were made under condition of the different working liquids (D₂O; H₂O) for the same Pd metal foils. As a result, it was clarified that only sono-powder (Pd[D₂O]) applied D₂O-working liquid generated extraordinary amount of sono-implanted D-atoms and “sono-helium”, but never in sono-powder (Pd[H₂O]) applied H₂O-liquid and also Pd[*virgin*]. These events are very important to know existence of “sono-solid fusion”, and similar events in other metals were also recognized.

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