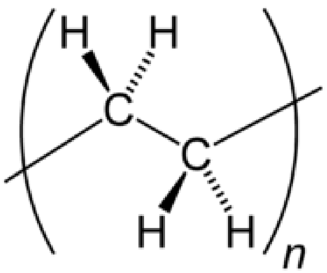
C9.* Analysis of Experimental Data Sets on XLPE by Kumazawa et al. [Kozima 2008a, 2010b, 2015, 2016c]

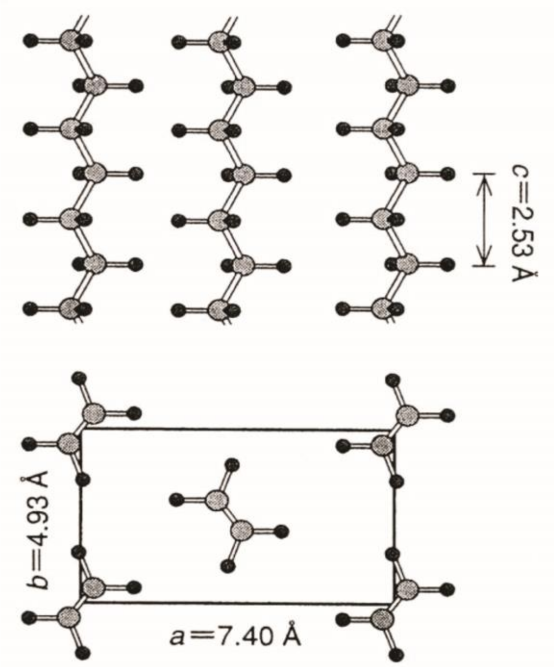
An explanation of the nuclear transmutation (NT) observed in the XLPE (cross-linked polyethylene) films dipped in aqueous electrolytic solutions with and without application of high-frequency electric field [Kumazawa 2005, 2006] was presented by the neutron-drop model used in the theoretical investigation of the cold fusion phenomenon in transition-metal hydrides/deuterides (CF materials). The NT's K → Ca, Mg → Al, $^{56}_{26}Fe$ → $^{57}_{26}Fe$ and Fe → Ni are explained by a single neutron absorption with or without a succeeding beta-decay to get final nuclides. On the other hand, the NT's $^{56}_{26}Fe$ → $^{64}_{30}Zn$ and $^{56}_{26}Fe$ → $^{60}_{28}Ni$ are explained by absorptions of a neutron drop $^{8}_{4}\Delta$ and $^{4}_{2}\Delta$, respectively, in the cf-matter that was supposed to be formed at boundary regions of crystallites in the sample. Production of wonderful elements Li, Pb and Bi is discussed from our point of view. [Kozima 2008a]

Thus, we have concluded that the generation of water trees in XLPE samples is caused by nuclear reactions induced by the CFP at around spherulites, a mechanism of which may be explained by the neutron-drop model proposed by us already. Furthermore, the new observation of the γ-ray emitted from ^{214}Pb and ^{214}Bi [Kumazawa 2007, 2012] is explained by the TNCF model [Kozima 2016c]. The NT found in XLPE may have a direct relation with the NT's found in biological systems (biotransmutations) as discussed in Appendix C12.

The excellent experimental data on the nuclear transmutation in cross-linked polyethylene had been obtained by Kumazawa et al. for more than 10 years from 2004 [Kumazawa 2005, 2006, 2007, 2012].

To show the essential feature of the atomic alignment in XLPE, we show its molecular structure in Fig. C9-1:





● ≡ H
○ ≡ C
Fig. C9-1 Lattice structure of XLPE orthorhombic lattice with lattice constants, *a* = 7.40 Å (740 pm), *b* = 4.93 Å (493 pm), *c* = 2.53 Å (253 pm) [Kozima 2010b (Fig. 5)].

We have analyzed the NT data in XLPE obtained by Kumazawa et al. [Kumazawa 2005] using the TNCF model successfully [Kozima 2010b]. The analysis has substantiated our approach to the NTs in hydrocarbons and we are encouraged to apply it to the biotransmutation (nuclear transmutation in biological systems) given in the next section.

Whole experimental data was tabulated in Table C9-1 and a part of typical data is qualitatively shown in Table C9-2 where are shown the increase (+) and decrease (–) of elements in Experimental compared to Original samples.

Table C9-1. Results of quantitative analysis for inorganic elements in XLPE sample (Table 6 of [Kumazawa 2005]).

Element	Dipped in KCl solution						Dipped in NaCl						Dipped in $AgNO_3$ solution		Original sample	
	Sample-A		Sample-B		Blank sample		Sample-A		Sample-B		Blank sample		Water-treed region	Not water-treed region		
	1	2	1	2	1	2	1	2	1	2	1	2			1	2
	[ng/g]	[ng/g]	[ng/g]	[ng/g]	[ng/g]	[ng/g]	[ng/g]	[ng/g]	[ng/g]	[ng/g]	[ng/g]	[ng/g]	[ng/g]	[ng/g]	[ng/g]	[ng/g]
Li	<1	N.D.	<1	N.D.	<1	N.D.	<1	N.D.	<1	N.D.	<1	N.D.	**170**	**36**	<1	N.D.
Na	<1	N.D.	<1	N.D.	<1	N.D.	**54**	**49**	7000	1300	6800	1500	**360**	75	50	45
Mg	140	70	70	110	230	180	**4**	**2**	58	55	49	46	20	14	43	46
Al	<1	N.D.	<1	N.D.	<1	N.D.	18	**130**	19	9	22	19	18	21	13	22
Si	<1	N.D.	<1	N.D.	<1	N.D.	<1	N.D.	<1	N.D.	<1	N.D.	N.D.	N.D.	<1	N.D.
K	20	N.D.	20	10	6	60	10	5	9	9	17	2	8	7	15	4
Ca	**5100**	160	190	**3200**	150	170	31	24	73	80	51	49	47	48	79	68
Cr	<1	N.D.	<1	N.D.	<1	N.D.	16	6	2	3	3	3	2	1	2	1
Fe	100	20	80	60	70	110	300	90	88	60	280	110	**14**	**18**	220	160
Ni	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	**9**	**40**	N.D.	N.D.
Cu	<1	N.D.	<1	N.D.	<1	N.D.	17	17	16	12	14	19	7	6	8	14
Zn	4	N.D.	2	N.D.	6	5	8	<3	3	<3	6	<3	4	23	15	13
Ag	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	19000	5200	N.D.	N.D.
Ba	<1	N.D.	<1	N.D.	<1	N.D.	<1	N.D.	<1	N.D.	<1	N.D.	N.D.	N.D.	<1	N.D.
Pb	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	**0.7**	**1.5**	N.D.	N.D.
Bi	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	N.D.	**2**	**6**	N.D.	N.D.

Table C9-2. Increase (+) or decrease (－) of inorganic elements in samples after voltage application (Table 9 of [1][Kumazawa 2005]).

Element	Isotopes	Sample		
		Dipped in KCl solution	Dipped in NaCl solution	Dipped in $AgNO_3$ solution
$_{3}Li$	$^{6}Li, ^{7}Li$			+
$_{11}Na$	^{23}Na		−	(+)
$_{12}Mg$	$^{24}Mg, ^{25}Mg, ^{26}Mg$		−	
$_{13}Al$	^{27}Al		+	
$_{19}K$	$^{39}K, ^{40}K, ^{41}K$	−		
$_{20}Ca$	$^{40}Ca, ^{42}Ca, ^{43}Ca, ^{44}Ca, ^{46}Ca, ^{48}Ca$	+		
$_{26}Fe$	$^{54}Fe, ^{56}Fe, ^{57}Fe, ^{58}Fe$			−
$_{28}Ni$	$^{58}Ni, ^{60}Ni, ^{61}Ni, ^{62}Ni, ^{64}Ni$			+
$_{47}Ag$	$^{107}Ag, ^{109}Ag$			(−)
$_{82}Pb$	$^{204}Pb, ^{206}Pb, ^{207}Pb, ^{208}Pb$			+
$_{83}Bi$	^{209}Bi			+

Characteristics in the changes of elements from (I) the Original to (II) the Blank and

(III) the Experimental samples were summarized as follows;

Case (a):

In the case (a) (KCl),

(1) K decreased and Ca increased,

(2) ^{56}Fe decreased and ^{57}Fe increased,

(3) ^{64}Zn increased while other isotopes of Zn decreased.

Case (b):

In the case (b) (NaCl),

(4) Mg decreased and Al increased in which the gross weight of the two elements was hardly different compared to the Blank or the Original samples.

Case (c):

In the case (c) ($AgNO_3$),

(5) Fe decreased and Ni increased,

(6) New elements Li, Na, Pb and Bi were detected, and

(7) There are changes of elements in both regions with and without water trees.

Furthermore, there are interesting features of the blank samples (II) in the case (a).

(8) In Blank samples, Mg and Ca are increased from those in the Original one while Fe is decreased.

In the paper by Kumazawa et al. [Kumazawa 2007], they reported detection of weak and burst-like radiation supposed to be low energy gamma or X-ray. In the CFP, there are a few observations of gamma and X-rays but are peripheral (cf. Section 6.3 of [Kozima 1998a] for the data of gamma ray observation). We give the essential part of our analysis on the data reported in the first paper [Kumazawa 2005] in this Appendix C9].

As discussed in Section 2 of our paper [Kozima 1998a], the crystalline portion of the XLPE sample has a similar physical properties to the transition-metal hydrides/deuterides where observed various events in the CFP. As we summarized above, there are several NT in the XLPE films that have corresponding ones in the CFP explained phenomenologically [Kozima 2006a]. We give explanations of the seven characteristics of the nuclear transmutations (NT) in XLPE giving counterparts in the CFP for reference;

(l) Decrease of K and increase of Ca in the case (a) are explained by such a reaction in the solids by absorption of a neutron followed by beta decay with a liberated energy ΔE= 1.31 MeV;

$$n + {}^{39}_{19}K \to {}^{40}_{20}K^* \to {}^{40}_{20}Ca + e^{-} + \underline{\nu}_e, \quad (\sigma_{nK39} = 2.10 \text{ b}) \qquad \text{(C9-1)}$$

where $\underline{\nu}_e$ is an anti-electron neutrino. As a measure of the reaction cross-section in solids we cited the value in free space in the parenthesis behind the equation, the corresponding examples of this type of NT in the CFP is given in Section 2.5.1 of [Kozima 2006a],

(2) Decrease of ${}^{56}_{26}$Fe and increase of ${}^{57}_{26}$Fe in the case (a) are similarly explained but without beta decay due to the stability of ${}^{57}_{26}$Fe with an energy Q = 1.15 keV transferred to the lattice system instead of gamma ray emission in free space;

$n + {}^{56}_{26}\mathrm{Fe} \rightarrow {}^{57}_{26}\mathrm{Fe} + Q.$ (σ_{nK39} = 2.10 b) (C9-2)

(3) Increase of ${}^{64}_{30}$Zn and decrease of ${}^{66}_{30}$Zn, ${}^{67}_{30}$Zn and ${}^{68}_{30}$Zn in the case (a) are explained by using the neutron drop ${}^{A}_{Z}\Delta$, for example;

${}^{56}_{26}\mathrm{Fe} + {}^{8}_{4}\Delta \rightarrow {}^{64}_{30}\mathrm{Zn}.$ (C9-3)

Many examples of this type in the CFP are given in Section 2.5.2 of [Kozima 2006a].

Decrease of other isotopes may be explained by nuclear reactions to transform them into other elements but its details are left for another work.

(4) Increase of Al and decrease of Mg in the case (b) are explained by reactions similar to (C9-2) with Q =7.08 MeV and Q' = 12.11 MeV and a reaction similar to (C9-1) with ΔE = 2.61 MeV.

$n + {}^{24}_{12}\mathrm{Mg} \rightarrow {}^{25}_{12}\mathrm{Mg} + Q.$ (σ_{nMn24} = 0.05 b)

$n + {}^{25}_{12}\mathrm{Mg} \rightarrow {}^{26}_{12}\mathrm{Mg} + Q'.$ (σ_{nMn25} = 0.19 b)

$n + {}^{26}_{12}\mathrm{Mg} \rightarrow {}^{27}_{12}\mathrm{Mg}^{*} \rightarrow {}^{27}_{13}\mathrm{Al} + + e^{-} + \underline{\nu}_e$, ($\sigma_{\mathrm{nMg26}}$ = 0.04 b)

(5) Decrease of Fe and increase of Ni in the case (c) are explained similarly with use of the neutron drop, for example;

${}^{56}_{26}\mathrm{Fe} + {}^{4}_{2}\Delta \rightarrow {}^{60}_{28}\mathrm{Ni}.$

(6) New elements with nucleon and proton numbers far from those of elements preexisted in the system were observed fairly often in the CFP.

There are several types of events producing such nuclides with largely shifted nucleon and proton numbers, A and Z, from those of original nuclides;

One of them similar to the case Li, Na, Pb and Bi may be the NT by transformation discussed in Section 2.5.4 of [Kozima 2006a], (There are observations of C from Pd and W systems, Cl from a Pd system, Fe in a carbon system, and Pb in a Pd system.)

(7) The occurrence of the NT in both of regions with and without water trees (by visual observation) might be evidence that the NT is not a result but a cause of the water tree generation. If seeds of water trees were born at boundaries or impurities in the disordered regions of the XLPE sample, as is said conventionally, the position is just where the cf-matter is tend to be formed by accumulation of neutrons in the neutron band. The larger the lamella in the spherulite, the easier the cf-matter formed and the

easier nuclear reactions occur there.

Thus, we may imagine a following scenario of growth of a water tree! (i) a NT of impurity nuclides occurs at a boundary region heating there by a liberated energy, (ii) a seed of a water tree is induced by the liberated energy, and (iii) the applied high-frequency electric field makes the water tree grow.

(8) The changes of amounts of elements in the blank samples from those in the Original in (a) support this scenario.