Preface to the Revised 2nd Edition (incomplete)

After the publication of the first edition of this book in 2006, it has lasted more than 10 years where appeared many impressive experimental and theoretical works in the old fusion phenomenon (CFP).

In the experimental phase, the nuclear transmutation and the stabilization of unstable nuclei (including the decay-time shortening) have been investigated extensively in traditional CF materials and furthermore observed in the carbon-hydrogen systems (cross-linked polyethylene and biological systems). These experimental results shed light upon the carbon-arc experiments performed 20 years ago without theoretical explanation on them. It should also be mentioned about the supra-critical electrolysis where the CFP in PtH_x and AuH_x systems is observed and explained by the TNCF model.

Observation of charged particles has been kept its effort since the first stage of the investigation of this phenomenon and enough data sets have been accumulated to be analyzed theoretically in these ten years. Localization of nuclear products at surface regions of CF materials has been recognized as a characteristic of nuclear reactions in the CFP. Many elaborate experimental data sets about the localization have been piled up in these 10 years succeeding the pioneering works performed in early years of 1990th.

In the theoretical phase, the most remarkable results are the discovery of three empirical laws (regularities) of nuclear reactions compiled from experimental data, one of which, the inverse-power law, had been described already in the first edition of this book. The three laws have been analyzed using analogy with complexity investigated in the nonlinear dynamics. By the discovery of the three empirical laws we could conclude that the fundamental characteristic of the CFP belongs to complexity.

Furthermore, the positive feedback and events of the explosion observed several times in this field have been elucidated scientifically.

The unified understanding of the CFP based on the TNCF model proposed by us in 1994 and developed to the ND (neutron drop) model to include rather complicated events of nuclear transmutation with large changes of A and Z has developed to encompass almost all events in the CFP. Investigation of the bases of the model expanded to relate the model with recent knowledge obtained in nuclear physics and solid-state physics. The idea of the neutron band figured out in the first edition as a source of the trapped neutron seems to have close relation with exotic nuclei having been observed in nuclear physics and with nonlocal wavefunctions of a proton and a deuteron in *fcc* transition metals in solid-state physics.

In the first edition of this book, emphasis was on the possible explanation of

occurrences of nuclear reactions in condensed matter at low energies (less than a few electron volts). There we could give a unified explanation on the diverse experimental data especially nuclear transmutations and excess energy production based on the phenomenological model – TNCF model – proposed by us. In this second edition, furthermore, we give rather complete explanation of several important phases of the CFP using analogy with complexity and contemplate theoretical bases – premises of the TNCF model – using the recent knowledge of nuclear physics and solid-state physics.

The cold fusion phenomenon as a whole has shown a new field of science in an interdisciplinary region between nuclear physics and solid-state physics in which nuclei on lattice points (lattice nuclei) interact each other through the super-nuclear interaction (a kind of strong interaction mediated by interstitial protons/deuterons). The new events including nuclear reactions observed in the CFP should reflect in the diffusion characteristics of protium and deuterium in *fcc* and *hcp* transition metals in the solid-state physics and in the stability of exotic nuclei in CF materials such as PdD_x and NiH_x in the nuclear physics.

Two fields of the CFP have been extensively investigated; the biotransmutation and the critical and supra-critical electrolysis. The former had been already treated by the TNCF model as early as 1996 [Kozima 1996a, 1998a] but there had been obtained new extensive data sets by Vysotskii et al. from 1996 to 2015. The latter included too complicated events to treat easily until the recent compilation in 2016 of experimental data obtained from 1996 to 2004 by T. Ohmori. The experimental data sets in these two fields have been extensively investigated [Kozima 2016d, 2017a] and included in this 2nd edition.

WE have investigated the cold fusion phenomenon phenomenologically using the TNCF model with an adjustable parameter n_n, the density of the assumed trapped neutrons. We have given the trapped neutrons several characteristics; they behave like free particles with the same thermal energy as the lattice of the CF material. They interact with disordered nuclei as if they are in free space with the absorption cross-section by nuclei determined in the nuclear physics. As we see in this book, our phenomenological approach has been successful to give unified and consistent explanation for almost all experimental data in the CFP.

We can now examine the meaning of our approach from a general point of view concerning the methodology of science. Then, it became clear that the phenomenological approach with the TNCF mode was an inductive method to a complicated problem governed by complexity. We notice that the analysis of the excess energy generation resulted in the inverse-power law (the second law of the CFP) is a kind of the meta-

analysis popular recently in the medical science. These problems will be discussed in JCF19 (will be held in November 2018) and included in Section 3.9 in this 2nd edition.

There are many enlargements and some corrections in many sections which have the same title as in the 1st edition. There are also many new sections added in this second edition which are asterisked in the Table of Contents.

As a concluding essay on the research of the cold fusion phenomenon, we have presented a paper "The Sociology of the Cold Fusion Phenomenon" at JCF17 held on March 2017 which was published in the Proceedings of the JCF17. We included this paper in this 2nd edition as the author's concluding essay on the Cold Fusion research developed in these 30 years.

The year 2016 was the hundredth anniversary of Einstein's general theory of relativity, which has given wide-spread and long-lived influence on the modern science, one of the recent example is the discovery of the gravitational wave in January, 2016. Larger the influence of a work on science, more difficult to be recognized the work by people. The cold fusion phenomenon itself seems to be an example of these themes difficult to be recognized its value by scientists in established fields.

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period in addition to the people who were listed in the Acknowledgements of the first edition of this book.

In this decade, we have lost many pioneers in this uncharted field. There are people who had personal contacts with the author including Makoto Okamoto (1938 – 1998), Koji Husimi (1909 – 2008), Andrei G. Lipson (1956 – 2009), Scott Chubb (1953 – 2011), Martin Fleischmann (1927 – 2012), John O`Mara Bockris (1923 – 2013), Richard Oriani (1920 – 2015), and especially John Dash (1933 – 2016). They had worked enthusiastically in this unknown field by trial and error. We know their struggles through many contemporary witnesses and thank them for their efforts against unscientific objections not based on facts. Please rest in peace now in the world without praise and censure.

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