Kasagi, J. and Y. Iwamura. *Country History of Japanese Work on Cold Fusion.* in *ICCF-14 International Conference on Condensed Matter Nuclear Science*. 2008. Washington, DC.

Country History of Japanese Work on Cold Fusion

J. Kasagi [1] and Y. Iwamura [2]
[1] *Laboratory of Nuclear Science, Tohoku University, Japan*
[2] *Advanced Technology Research Center, Mitsubishi Heavy Industries Ltd., Japan*

Abstract

We briefly summarize the history of Japanese work on cold fusion after 1989. Since the excellent work performed by Prof. Arata are introduced and discussed in the special session, we try to summarize other works in Japan. The history can be divided into three periods: the 1st period is from the announcement by Fleischmann and Pons to the ICCF3 Nagoya Conference (1989 - 1993); the 2nd period is during the New Hydrogen Energy (NHE) Project (1994 – 1998); and the 3rd after the NHE project (1999 – present). Characteristics of each period and the present situation are presented.

1. Introduction

In the 19 years following the announcement of Professors Martin Fleischmann and Stanley Pons, much work on the cold fusion has been carried out in Japan as well as in other countries. The organizers of this conference have asked us to edit a document on “cold fusion” research in Japan. Many official reports for various projects, proceedings of domestic meetings on cold fusion and research papers describe the progress of this research in Japan. Thus, we thought that it is worthwhile to collect and summarize such records as an interim report in the cold fusion research. Since the excellent works performed by Prof. Arata were introduced and fully discussed in the special session of ICCF14, we have tried to summarize other work based on many official reports in Japan.

The history of cold fusion research in Japan can be divided into three periods: the 1st period is from the announcement of F-P to the ICCF3 Nagoya Conference (1989 - 1993), the 2nd period is during the New Hydrogen Energy (NHE) Project (1994 – 1998), and the 3rd after the NHE project (1999 – present), as schematically shown in Fig. 1. We will show background and characteristics of each period, as well as notable research.

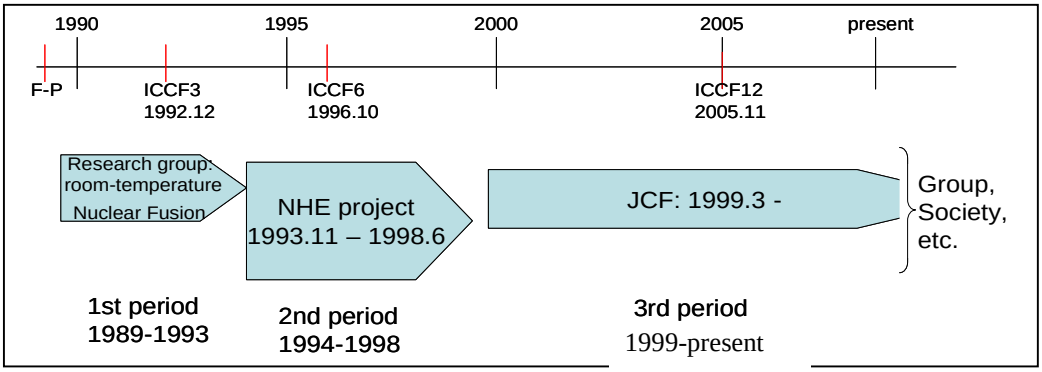

Figure 1. Outline of Japanese Cold Fusion History

1. The first period (1989 – 1993)

Two months after the F-P announcement, a room-temperature nuclear fusion research group was established under the leadership of Prof. Ikegami of National Institute for Fusion Science (NIFS). The group initially (June, 1989) consisted of about 40 persons, from 15 Universities and NIFS, who had been heavily involved or keenly interested in cold fusion work from the beginning. The financial background of research activity was one-year special support from the Grants-in-Aid of Priority Area of Nuclear Fusion by Ministry of Education. Many researchers and groups were involved in the group and its members increased to 110 researchers from 26 Universities and 5 Research Institutes by December 1989. In addition, there were individual studies, also, which were performed independently: for example, those of Profs. Arata and Zhang.

In 1990, the proposal for a Study of Cold Nuclear Fusion (representative: Prof. Ikegami) was accepted as Grant-in-Aid of Scientific Research (Synthetic (A)) for 2 fiscal years. However, the amount of the grant was not large enough to support individual experiments so it was mainly used to keep active research in the group by organizing a co-operative study, travel expenses, information exchange, meetings and so on. In the official report seen in the data base of Grant-in-Aid in Scientific Research, Prof. Ikegami summarized the progress of the cold fusion research as follows:

Hydrogen absorption in Pd metal were studied in detail (Ohta, Fujii, Mizuno)
Excess heat phenomena were replicated (Oyama, Ohta, Takahashi, Mizuno)
A high efficiency neutron detection system was developed (Nakazawa, Shibata, Maeda)
Element dependence of Cosmic-ray origin spallation neutrons was studied (Shibata, Nakazawa)
Neutron emission was confirmed in electrolysis of heavy water as well as in gas method (Ikegami, Tajima, Okamoto, Aizawa)
Energy spectra of emitted neutron were measured (Takahashi, Numata, Mizuno)
High energy charged particles were observed (Yamaguchi)
Anomalous production of tritium and ^{3}He were observed (Takahashi, Mizuno, Adachi)

The results of these studies had confirmed the occurrence of the cold fusion. However, mechanism of cold fusion was still unknown. Also performed were studies of muon catalyzed

fusion (Nagamine), beam impact fusion (Lee, Kasagi) and fractofusion (Fukai, Maeda) which were considered related to cold fusion.

In this period, 4 other groups got Grant-in-Aid of Scientific Research from the Ministry of Education in addition to Ikegami's group: Totsuka G. at Univ. of Tokyo (1990-91, neutron measurement using Kamiokande), Yamaguchi G. at Tohoku U. (1990-91, DD cross section in Ti), Baba G. at Osaka U. (1990-91,) and Ohta G. at Yokohama National U. (1992,). However, the subsequent research proposal with much larger size for 1992-1995, Grant-in-Aid of Priority Area of Nuclear Reactions in Condensed Matter (representative: Prof. Okamoto at Tokyo Institute of Technology) was not accepted.

Contributions of this period were concentrated in ICCF3 which was held at Nagoya from October 21 to 25, 1992. There were more than 200 Japanese participants and 10 contributions from Japan were selected as invited papers. Top authors included K. Kunimatsu, N. Oyama, K. Ohta and A. Takahashi for Excess Heat, N. Nakada; E. Yamaguchi, T. Iida and J. Kasagi for Nuclear Products; M. Enyo and Y. Fukai for Materials and Hydrogen Behavior. In addition, a special panel discussion was organized for the Takahashi method (L-H mode electrolysis) with examples to improve reproducibility. The most important result which Prof. Ikegami remarked on in the Conference Proceedings was the work of Drs. Yamaguchi and Nishioka: "they detected helium and energetic alpha particles which may be a possible energy carrier for excess heat." The report in ICCF3 was the extended description of their original method first published in Jpn. J. Appl. Phys. **29** (1990) L666, three years before ICCF3.

Based on the success of the ICCF3 as well as many important contributions of Japanese work, Prof. Ikegami and Mr. Nanba (Technova Inc.) proposed a project of cold fusion research, or " new hydrogen energy" to the Ministry of International Trade and Industry (MITI, as it was called at that time). To realize the project, Technova Inc. had arranged a world-wide investigation on status of cold fusion in early of 1993. The proposal was finally accepted by MITI and the New Hydrogen Energy (NHE) project started in November 1993.

2. Second period (1994 – 1998)

The NHE project consisted of two parts: one was NHE R&D project, and the other was Basic Research project. The former was the main project (and it was called the NHE project) subsidized by MITI for 5 years with total budget of about 2.5 billion JPY. It was entrusted to the Institute of Applied Energy (IAE) through the New Energy and Industrial Technology Development Organization (NEDO). IAE provided R&D Center for NHE (director: Dr. K. Matsui) and NHE Laboratory (director: Dr. N. Asami). Six companies, Mitsubishi Heavy Industry, Hitachi, Toshiba, Aisin Seiki, Tanaka Kikinzoku and Nuclear Fuel Industry, participated in the project and sent researchers to the NHE Laboratory. Its main goal was reproducing and verifying the existence of excess heat generation and nuclear products during electrolysis in Pd-LiOD system.

The NHE Basic Research project was arranged to support basic research performed by university personnel, since the subsidy for the NHE R&D project from MITI was only for private enterprises. The Basic Research Project was regarded as an auxiliary project and the fund was provided by supporting companies; in addition to the 6 companies above, 9 electric power companies, Tokyo Gas, NTT, Nippon Steel, J-Power and Japan Atomic Power supported the Basic Research project. The representative of the project was Prof. Okamoto at the Tokyo

Institute of Technology. The project was organized as shown in Fig. 2 where the relation with the R&D project is also given.

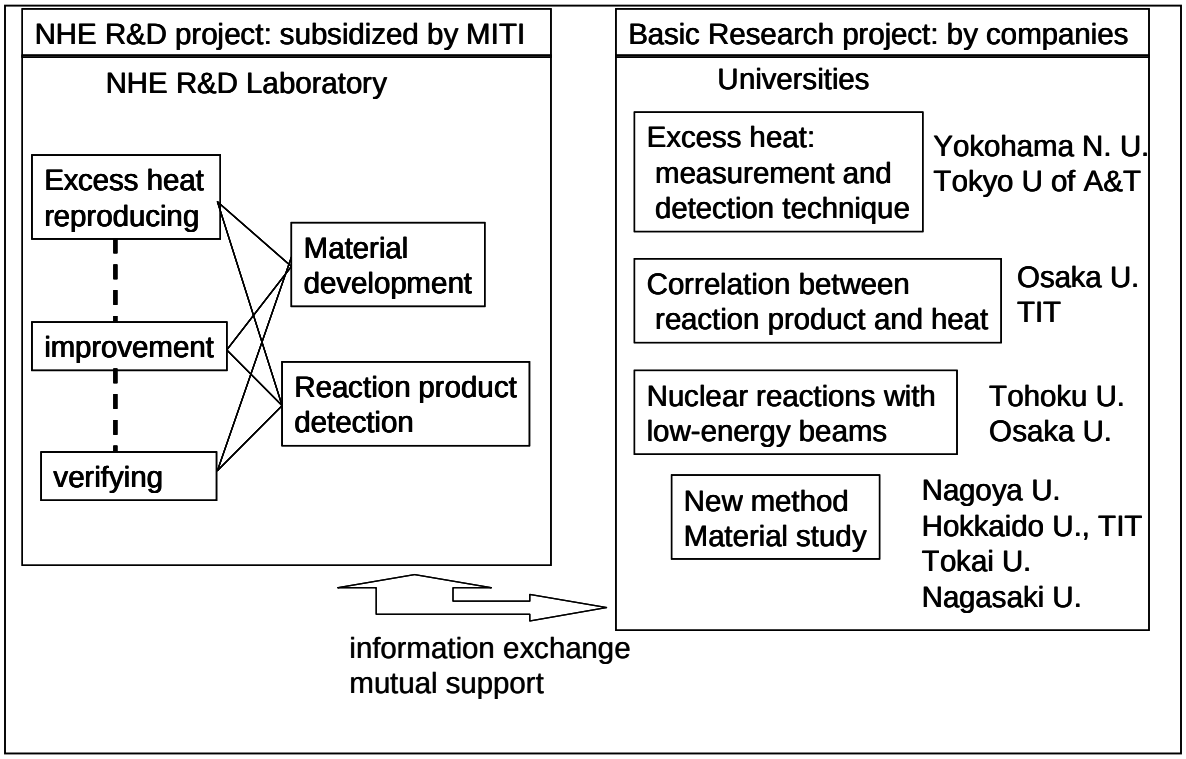

Figure 2. NHE R&D and Basic Research Projects

The start of the official project supported by MITI with reasonable amount of funds was very promising. Many researchers were able to carry out their studies around the main NHE R&D project in this period. The research funds for the Basic Research played a key role in continuing and developing high quality studies at various universities. Several private companies started their own experiments, in addition to the participation in the NHE R&D project; they included IMURA, MHI, NTT, Toshiba, Honda and so on. Meetings were held almost annually; both university and industry researchers participated. International exchange was promoted by the NHE project: several researchers from USA, Russia and Italy worked at NHE Lab and Universities. The IAE organized ICCF6 in October 1996 at Lake Toya.

The NHE project ended in June 1998.

During this period, the NHE Laboratory carried out the excess heat measurements on more than 500 specimens. The official report of the NHE R&D project was summarized for the excess heat measurements as follows:

(1) No apparent excess heat was observed over instrumentation limits after about 500 of electrolysis experiments by some kinds of well-developed cells.

(2) This means that we failed to verify the existence of excess heat at the level which was expected at the beginning of the project. We concluded that it is hard at present to utilize the “new hydrogen energy” for practical purposes with the present science and technology in this field.

(3) Of course, we do not deny the possible existence of solid state nuclear reactions being unknown up to now and its possible trace amount of heat. However the phenomena still remains within a scope of fundamental research.

An important contribution in this period was a finding of anomalously large screening potential in D+D reaction in metal observed by Kasagi *et al*. It should be noted here that this work benefitted a great deal from the NHE project for the basic equipments. The first result was reported at ICCF7 in April, 1998, and was published in JETP Lett. **68** (1998) 823. Prof. Bressani remarked on it in summary talk of ICCF7: "The first "miracle" of Cold Fusion observed in a typical Nuclear Physics Experiment: It is a dramatic proof of the influence that condensed matter effects may have on nuclear observable."

3. Third period (1999 – present)

After the NHE project ended, the organization of cold fusion research met with several problems. The number of active researchers has not increased but rather decreased. This is mainly due to retirement or passing away of senior researchers from universities. There are almost no newcomers in this field. Research groups lost government funded support. The funding situation has not improved, because the NHE project could not change the attitudes of mainstream scientists. What was needed was to show and discuss the results of cold fusion and related work to many people outside this field. Such efforts have been done in this period.

In late of 1998, Prof. A. Takahashi at Osaka University proposed the establishment of a society in this field. The Japan C-F Research Society (JCF) was established and held a kickoff meeting in January 1999 at Osaka Univ. ("C-F" can be considered an abbreviation of "cold fusion," "condensed matter fusion," "chemical assisted fusion," etc.) Since then, the JCF has held the annual meeting every year as shown in Table 1. The number of members has been about 50 and Proceedings of the annual meeting have been published since the 4th meeting.

Prof. Takahashi and Dr. Iwamura endeavored to introduce the science and technology of cold fusion and nuclear transmutation to people in the atomic energy field. They established a committee in Atomic Energy Society of Japan. Holding committee meetings several times on various subject on cold fusion and related subject, they succeeded in organizing a special session "Nuclear phenomena in condensed matter in the sub-keV energy region" at the Annual Meeting of Atomic Energy Society in April, 2004. The special committee is still in effect. Prof. Kasagi at Tohoku Univ. has organized small workshops on wider concept of nuclear phenomena in condensed matter, occasionally, with researchers in physics field; Nuclear Physics and Condensed Matter Physics. These meetings in this period were shown in Table 1.

Table 1. Meetings on Cold Fusion in Japan after the NHE project

Meetings: JCF annual meeting
organized by special committee in Atomic Energy Society of Japan
workshop held at Laboratory of Nuclear Science

1999.3 JCF1 at Osaka U. (The 1st meeting of the Japan C-F Research Society)
2000.3 Workshop on Anomalous Nuclear Fusion Reactions
(at Arata Hall in Osaka U., organized by Shibata and J. K.)
2000.9 Workshop on Change of nuclear lifetime in various conditions
2000.10 JCF2 at Hokkaido U.
2001.10 JCF3 at Yokohama National U.
2002.10 JCF4 at Iwate U.
2003.5 kickoff meeting
2003.7 meeting for permeation experiments
2003.10 meeting for beam experiments
2003.11 FUSION03 (Nucl. Phys. Int. Conf. organized by Takigawa and J.K.)
two sessions for nuclear fusion reactions in matter
2003.12 JCF5 at Kobe U.
2004.3 Workshop on Low-energy nuclear reactions in various phases
2004.4 Special session in Annual Meeting of Atomic Energy Society of Japan
Nuclear phenomena in condensed matter in the sub-keV energy region
2004.6 meeting for transmutation experiments
2004.8 meeting for theory
2005.4 JCF6 at TIT
2005.8 meeting for permeation experiment and recent topics
2005.11 ICCF12 at Yokohama
2006.4 JCF7 at Kagoshima U.
2007.11 JCF8 at Doshisha U.

The number of active researchers has been decreasing in this period. At present, experimental groups (principal researchers) are as follows: Hokkaido Univ. (Mizuno), Iwate Univ. (Yamada, Narita), Tohoku Univ. (Kasagi, Fukuhara), Tokyo Inst. Tech. (Numata), Kobe Univ. (Kitamura), MHI (Iwamura), MHI (Iwamura), Toyota Lab. (Hioki). In addition, theoretical works have been continuously performed by Profs. Takahashi (Osaka), Kozima (Shizuoka) and Tsuchiya (Tokyo).

Two groups have obtained Grant-in-Aid for Scientific Research from Japan Society for the Promotion of Science (JAPS) in this period; Yamada at Iwate Univ. (1999-2000, 2002-2003, 2004-2005) and Kasagi at Tohoku Univ. (2002-2003, 2004-2006, 2007-2010). Another funding association for the cold fusion research has been the Thermal and Electric Energy Technology Foundation (TEET: Minoru (Toyota) Memorial Foundation); one or two researchers in the cold fusion field have obtained the fund each year since 2003.

An important contribution in this period was the transmutation experiments developed by Dr. Y. Iwamura; it was firstly reported at ICCF9 in Beijing and was published in Jpn. J. Appl. Phys. **41** (2002) 4642. Dr. T. Chubb remarked on it in ICCF10 News Flash; “Probably the most important of the results were those concerned with a unique form of nuclear transmutation reported a year ago by Iwamura *et al.* of Mitsubishi Heavy Industries.”

4. In the Future

As described above, Japanese researchers have contributed a great deal to cold fusion research in the last 19 years. However, the present situation is not promising for the future. The research faces many problems in Japan. First, no big project with research fund has been accepted after the NHE project; i.e., only small funding, moreover, for a few groups. This is partly due to the fact that cold fusion research is not considered legitimate science by many mainstream scientists. Thus, any proposal for cold fusion research will, for all practical purposes, be summarily rejected, and there is no development effort underway for heat production efforts except for Profs. Arata and Zhang and Dr. Mizuno. Second, the decreasing number of active researchers is serious. This is due to the retirement of university personnel, which means that the research group in university disappears and no students can be trained in this field. Thus, the most pessimistic view is that cold fusion research in Japan will disappear within a few years because of the retirements in Hokkaido Univ., Tohoku Univ., Yokohama National Univ., and so on.

How can we find our way out of this situation? There is no secret way, needless to say. We should make every effort to obtain good and convincing data showing clear nuclear origin, and to apply to various organizations for research funding. When one says Condensed Matter Nuclear Science, one can imagine a much broader concept than that of cold fusion or nuclear transmutation. Since the connection of the nuclear degree with the condensed matter degree is essential, it may help to plan a larger project to explore fundamental research including various nuclear phenomena in condensed matter; phenomena related to nuclear reaction, nuclear fission, nuclear decay, nuclear excitons, neutron scattering, etc. The participation of scientists from established fields is indispensable in stimulating discussions and exchanging ideas.

Acknowledgments

We did not have enough opportunities to discuss this review with the researchers, we did receive various comments which are appreciated.

General References

Data base for Grant-in-Aid in Scientific Research (JSPS) (in Japanese)
NHE R&D progress report: issued by NEDO from FY1993 to FY1997 (in Japanese)
Report on evaluation of the NHE project; issued by NEDO, 1998.6 (in Japanese)
NHE Basic research progress report: issued by IAE from FY1993 to FY1997 (in Japanese)
Proceedings of JCF meetings
Proceedings of ICCF conferences