Chapter 1

Introduction

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This introduction presents views on the topics of low-energy nuclear reaction and bubble nuclear fusion research and provides an overview of the papers in this volume.

Low-Energy Nuclear Reactions and New Energy Technologies Sourcebook Volume 2 communicates recent exemplary work in low-energy nuclear reaction and new energy technology research.

This book is by no means a complete reference for the extensive work that has been performed in these fields. However, taken in the context of other volumes, it is a reliable resource and broad reference tool.

This sourcebook continues the presentation of some of the best experimental and theoretical research in the LENR field. As well, this volume includes another novel area of nuclear energy research, bubble nuclear fusion.

The evidence for a new class of inexpensive nuclear energy research topics is now unambiguous, though its road to recognition has been a bit slow, bumpy and, at times, treacherous for its intrepid explorers.

The roots of most of the work in this book began 20 years ago, triggered by the greatest science controversy in modern times: the cold fusion episode.

"Cold fusion" was the term used by the media 20 years ago to identify the discovery of Martin Fleischmann and Stanley Pons, at the University of Utah, of an unexplained source of heat resulting from an electrochemical cell using heavy water and palladium. The work of Fleischmann and Pons did not suddenly appear without context, despite appearances to the contrary. Fleischmann had been curious about the strange behavior of palladium and deuterium since his college days and his fascination with Nobel laureate Percy Bridgman's "cold nuclear explosions."

This volume contains two comprehensive reviews. The first, by Jean-Paul Biberian, reviews LENR research performed with deuterium gas. This review is particularly useful because potential LENR applications seem far more likely to use gas-based devices than the messy environment of electrochemistry.

The second review, by Mahadeva Srinivasan, provides an overview of perhaps the most significant government LENR research, that of the Bhabha Atomic Research Centre in India *(1)*. The researchers at BARC devised interesting experiments and produced results right away after hearing the news of the Fleischmann-Pons discovery from the University of Utah. The directors at BARC demonstrated remarkable initiative and were able to marshal the resources of scientists in many fields and get them all to work together. Their work stopped in the early 1990s, not for lack of results but for lack of courage. A new administration took over in the early 1990s that was less-courageous in the face of the growing negative public opinion of the controversial research despite the positive results of its own researchers. Nevertheless, the BARC work shows what is possible when scientists and government leaders in a country are aggressive, open-minded and prepared.

Although the BARC work was performed two decades ago, its value has never been more appreciated because new insights into reproducible neutron signals *(2)* and neutron-based ideas, such as the work by Srivastava, Widom, and Larsen in this volume, have recently opened new vistas for the LENR field.

Four LENR experimental papers are presented in this volume. These papers represent but a fraction of the experimental knowledge that has been developed. Each author or group of authors naturally takes an approach with a certain hypothesis in mind. Some of the researchers explore the work from the aspect of a new form of room-temperature fusion or fission; others look at the work from the aspect of neutron-catalyzed reactions. The three approaches do not necessarily imply three distinct groups of phenomena; rather, they are more likely to be representative of each researcher's area of focus, perspective and expertise.

This book also contains a chapter on bubble nuclear fusion, a unique phenomenon that, through a multibubble sonoluminescence effect, produces a tabletop thermonuclear reaction. This work falls into the broader category of research called acoustic inertial confinement fusion. AICF has been studied for many years in single-bubble sonoluminescence research, but not until a group at Oak Ridge National Laboratory, led by nuclear engineer Rusi Taleyarkhan, applied its novel ideas to create multibubble sonoluminescence did the thermonuclear reactions take place.

The political backlash that occurred in 2007-09 against pioneer Taleyarkhan - largely the result of academic backstabbing - is reminiscent of the fate suffered by Fleischmann and Pons 20 years ago. Thus, the clear presentation of the scientific facts in this volume becomes all the more crucial in the face of the nonscientific assaults against these novel areas of research.

Immediately following the chapter on bubble nuclear fusion is a chapter by Roger Stringham presenting work that also uses acoustic triggering but that falls within the LENR category.

"Cold fusion" researchers were labeled heretics for their willingness to consider ideas deemed ridiculous by the physics orthodoxy. Many skeptics missed the point: The field did not originate from the speculative theoretical imaginations of Fleischmann and Pons. The field blossomed as the result of empirical studies.

Viable theories may bring comfort to cautious observers and the science orthodoxy, but the LENR phenomena did not arrive replete with such. It is now the job of theoretical physicists, teamed with the experimentalists from a broad variety of disciplines, to develop an understanding of the mechanism or mechanisms that will explain the anomalous nuclear-scale energy and nuclear products that will enable this science to progress to a technology.

The careful reader will note two levels of argument represented by the LENR papers. The first argument is for the fundamental establishment of the validity of the research in general. The second argument - more subtle in the case of the experimental work but more obvious in the theoretical work – is for the existence of room-temperature deuterium-deuterium fusion reactions versus the argument for proton addition by way of neutron absorption.

Among the arguments presented for the underlying mechanism or mechanisms of LENR, the reader will find proposed models for fusion, fission and electro-weak processes. Regardless of the outstanding question of the underlying processes, an honest reader will find it difficult to dismiss the fact that a new field of nuclear research has arrived.

Many of the experimentalists assume or speculate that the causative nuclear events are fusion processes, though in many, if not all, cases, the evidence for fusion is far removed from and poorly matches that which is well-understood as the recognized phenomena of thermonuclear fusion. Some LENR researchers interpret their solitary findings of 2.5 MeV neutrons or 3.0 MeV protons as unambiguous proof of deuterium-deuterium fusion. Evidence the findings may be; proof they are not.

The struggle for understanding should not be seen as a distraction from the relevant importance of the overall subject and the legitimate search for answers. No doubt, Nature is showing us something new and, most likely, something significant. Potential applications based on these areas of research are intriguing. However, the immediate opportunity to learn, share and expand scientific knowledge and explore the edge of science is here today.

References

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2. Mosier-Boss, P. A.; Szpak, S.; Gordon, F. E.; Forsley, L. P. G. Triple Tracks in CR-39 as the Result of Pd–D Co-Deposition: Evidence of Energetic Neutrons. *Naturwissenschaften* **2008**, *96*, 135-142.