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COMMENTARY

New Life for Cold Fusion

Henry H. Bauer
207 Woods Edge Court, Blacksburg, VA, USA 24060-4015
hhbauer@vt.edu

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Abstract—The take-away from this discussion is that research on nuclear reactions occurring at ordinary temperatures in certain metals with electrolysis in heavy water ("cold fusion"), which has been widely denigrated for three decades as "pathological science," has now been recognized by mainstream sources as a respectable topic for further research.

Keywords: cold fusion; low-energy nuclear reactions (LENR); condensed matter

BACKGROUND

In many quarters, in most of the mass media, "cold fusion" has remained among the class of pseudo-scientific topics, analogous to perpetual-motion machines: mistakes fueled by sloppiness or wishful thinking, or perhaps deliberate hoaxes; at any rate, not to be taken seriously.

Cold fusion had made its debut in 1989 at a press conference at the University of Utah when Stanley Pons and Martin Fleischmann revealed that they had observed, in electrochemical cells with palladium (Pd) electrodes and heavy water (D_2O), the generation of heat so great that it could be attributed only to nuclear rather than chemical reactions.

A spate of hurried attempts at replication followed all over the world, often by groups with no experience in electrochemistry. They failed to confirm the claim, which was quickly labeled as "pathological science," primarily by the physics community.

Nevertheless, quite a large number of researchers, chiefly

electrochemists, continued to work in the belief that Fleischmann and Pons were on to something; Fleischmann in particular was a highly respected scientist. As a result, the field came to be described not as cold fusion but as Condensed Matter Nuclear Science (CMNS) or Low-Energy Nuclear Reactions (LENR); and by 2019 the International Society of CMNS was publishing the 29th volume of its journal (iscmns.org); LENR-CANR.org boasts a library of 4,500 journal articles on the subject; and there have been more than 20 international conferences on the matter.

Nevertheless, the subject remained anathema in mainstream circles, so it was a surprise when an acknowledged mainstream source widely regarded as authoritative, *Nature* magazine, published "Revisiting the cold case of cold fusion" (Berlinguette et al., 2019) together with an Editorial preview (*Nature* Editorial, 2019) of the article.

Unsurprisingly, *Nature*'s Editorial was snarky and misleading, in asserting that "The phenomenon—even if real—seemed ephemeral and had little to no theoretical basis." In fact, Fleischmann had long been intrigued by widely acknowledged oddities in the electrolysis of aqueous solutions at Pd electrodes, and he had pointed out that sufficiently high overvoltage (away-from-equilibrium electrode-potential) would correspond to pressures of D in Pd comparable to what "hot" fusion research is aiming to achieve (Bauer, 1990). "The team found **no evidence <u>whatsoever</u> of cold fusion"** [emphases added]. Yet it was acknowledged that "The group was unable to attain the material conditions speculated to be most conducive to cold fusion." So the lack of evidence means nothing beyond the experimenters' failure to achieve the conditions that McKubre's group (see below) had achieved.

It is worth bearing in mind always that *Nature* (as also *Science*) suffers the self-inflicted dilemma of aiming to be both authoritative and also first with news of important advances (Bauer, 2012, pp. 67–69; Bauer, 2017, pp. 110, 162). In practice, rarely will *Nature* publish anything counter to the conventional wisdom, no matter how many well-qualified but maverick experts support the unorthodoxy (Bauer, 2017, pp. 193–194).

By contrast to *Nature*'s Editorial comment, Berlinguette et

al. (2019) regarded their 4-year project as yielding useful knowledge and urged other researchers to "produce and contribute data in this intriguing parameter space. . . . the search for a reference experiment for cold fusion remains a worthy pursuit because the quest to understand and control unusual states of matter is both interesting and important." That positive conclusion may explain why it took *Nature* a year to publish the article ("Received 25 May 2018; Accepted 11 March 2019; Published online 27 May 2019"). Another inducement to publish may have been that the new research on cold fusion had been instigated by Google.

MCKUBRE'S COMMENTARY

McKubre is an electrochemist, now retired from Stanford Research Institute (SRI), who has worked on "cold fusion" almost from the beginning and has participated prominently in the associated conferences and organizations. Moreover, he had been in touch with Google and the prospective researchers when the Berlinguette project was initiated five years ago. In a Commentary in *Infinite Energy* (McKubre, 2019), McKubre points out the benefits accruing from the publication of Berlinguette et al. (2019) in *Nature*. First, that the work was stimulated by Google's recognition that the existing known sources cannot satisfy the future energy needs of Earth's growing and developing population. Second, the article confirmed one of the points McKubre's own work had established, namely that the phenomenon could be observed only when the ratio of absorbed D atoms to metal-lattice Pd atoms exceeds 0.875. Third, the very fact of publication in *Nature*, which up to now had deliberately and studiously treated the subject as beyond the pale, represents an inestimably significant breakthrough that can serve to open doors for venturesome young researchers to carry the work forward.

McKubre also makes two serious criticisms: First, the article gives a misleading view of what "cold fusion" researchers have ventured as possible mechanisms. Soon abandoned was the simplistic notion that what occurs is essentially the same in terms of fusion products as in hot fusion. Rather, its occurrence in the solid state—inside the Pd electrode—means that the palladium-metal lattice plays a crucial role. That is why the research community adopted the name Condensed

Matter Nuclear Science (see iscmns.org) to replace "cold fusion." Second, the article ignores previous work that had shown the need not only for high loading of gas into Pd but also for sufficiently high current-density applied for periods as long as several weeks, before the heat observed by Pons and Fleischmann would manifest.

The takeaway moral is that research on nuclear reactions occurring in the solid state in certain metals at ordinary temperatures, generally classed as pathological science for three decades, has been recognized as respectable for mainstream researchers, which should bring resources and general support that has been lacking up to now.

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