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Excess heat evolution from nanocomposite samples under exposure to hydrogen isotope gases

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ABSTRACT

Anomalous heat effect by interaction of hydrogen isotope gas and metal nanocomposites supported by zirconia or by silica has been examined. Observed absorption and heat evolution at RT were not too large to be explained by some chemical processes. At elevated temperatures of 200–300 °C, most samples with binary metal nanocomposites produced excess power of 3–24 W lasting for up to several weeks. The excess power was observed not only in the D-Pd·Ni system but also in the H–Pd·Ni system and H–Cu·Ni system, while single-element nanoparticle samples produced no excess power. The Pd/Ni ratio is one of the keys to increase the excess power. The maximum phase-averaged excess heat energy exceeded 270 keV/D, and the integrated excess heat energy reached 100 MJ/mol-M or 90 MJ/mol-H. It is impossible to attribute the excess heat energy to any chemical reaction; it is possibly due to radiation-free nuclear process.

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Introduction

There have been continuing interests in research on various effects by hydrogen-gas charging of transition metal compounds, for application to energy storage devices and catalyser materials, and so on. The interest increased further, when palladium was used as a cathode of heavy water electrolysis to charge with hydrogen isotopes and induce extraordinarily large energy, the so-called cold fusion,

Glossary: AHE, (anomalous heat effect); MHE, (Metal-Hydrogen Energy); RT, (room temperature); ET, (elevated temperature); RC, (reaction chamber); ST, (storage tube); RTD, (resistive temperature detector); TC, (thermocouple); MPS, (mesoporous silica); FRM, (flow-rate-meter); LOCA, (loss-of-coolant accident).

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claimed by Fleischmann-Pons in 1989. The phenomena are considered to be induced by some anomalous reactions continuing for more than weeks with reaction energies larger than chemical reactions by more than several orders of magnitude. Since then a number of experiments have been performed to reproduce the phenomenon, namely the anomalous heat effect (AHE), with use of palladium. However, most of them have been unsuccessful in replication. Only a few experiments claimed positive results using the electrolysis method or the gas-phase charging method.

Recently, nickel-based nanocomposite samples have come to gather attention owing to higher availability of nickel than palladium. A Ni·Cu·Mn alloy thin wire, for example, has been examined extensively by Celani et al. [1]. In addition, a number of entrepreneurs are publicizing their own "products" of nanofabricated samples on web sites with undisclosed details, and therefore with little scientific corroboration [*e.g.* Refs. [2,3]]. Among them, replication experiments of the Rossi-type reactors have been performed by several researchers [4–7], which seemingly appears to show unignorable reproducibility of the Rossi method. However, little is known about the accuracy of the calorimetry and the mechanism of the claimed anomalously large energy production.

On the basis of the 8 year-long (2008–2015) series of study on the AHE by interaction of metal nanoparticles and D(H)-gas under the collaboration of Technova Inc. and Kobe University, a collaborative research project has begun aiming at scope of industrial application to a new CO_2-free, distributed energy source [8]. Based on the Technova-Kobe works, new project on MHE (Metal-Hydrogen Energy) was started on October 2015 under the collaboration of six Japanese organizations, one of which the individual author of the present paper belongs to. The results of the early-stage research program were reported in 20th International Conference on Condensed Matter Nuclear Science (ICCF20) [9,10], 17th Meeting of Japan CF-research Society (JCF17) [11,12] and 12th International Workshop on Anomalies in Hydrogen Loaded Metals [13,14].

In the present paper, we report results of observation of AHE by interaction of hydrogen isotope gas and nanocomposite samples done as the collaborative work using the experimental apparatus installed at Kobe University [15–18].

The system has a reaction chamber containing the sample with a capacity of 500 cc, and an oil-flow-calorimetry system capable of working at elevated temperature (ET) up to about 350 °C with use of a synthetic liquid hydrocarbon coolant, Barreltherm-400 (BT400). The samples tested so far as the collaborative work include both zirconia-supported and silica-supported metal nanoparticles. In the present paper, hydrogen isotope (D or H) absorption and heat-generation characteristics of the samples are discussed with emphasis on those under rather constant pressure condition after initial D(H)-absorption process or even during effectively net desorption process at elevated temperature.

Experimental procedure and samples

A schematic of the D(H)-gas-charging-calorimetry system C_1 is shown in Fig. 1. The reaction chamber (RC) containing the sample has two kinds of electric heaters to elevate the temperature of the sample; one wounded around the RC capable of giving the power (W_1) of up to 1 kW, and the other inside the RC through the bottom flange giving the power (W_2) up to

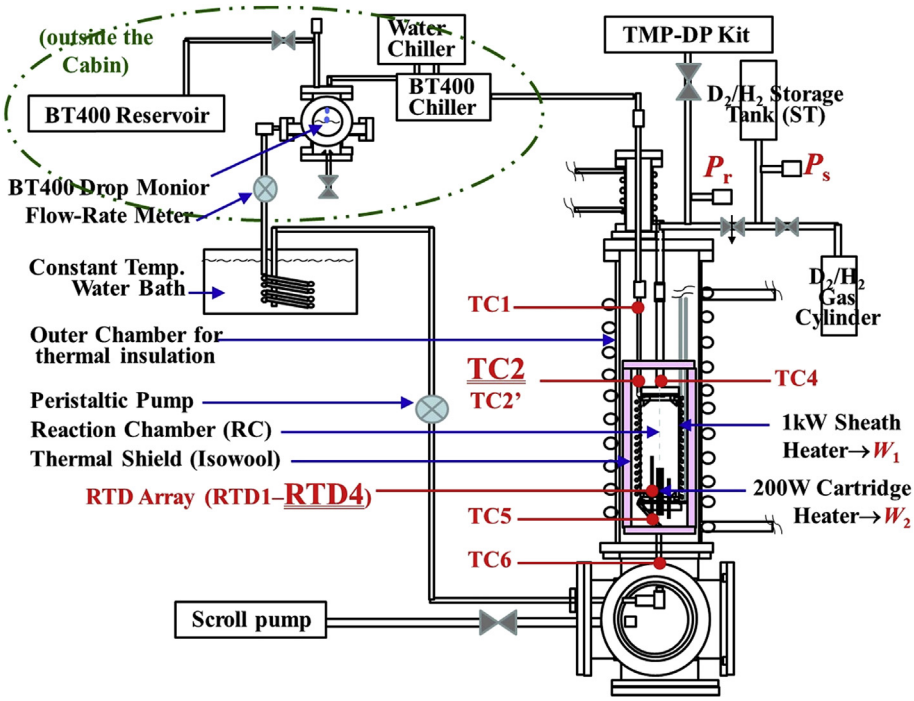

Fig. 1 – Schematic of C_1 MHE-experimental system equipped with oil-flow-calorimetry system with flow-rate-monitors and dual heaters mounted on the reaction chamber (RC).

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