Direct Joule Heating of D-Loaded Bulk Pd Plates in Vacuum

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A gas-phase experimental research in quest of condensed-matter fusion is underway by using multilayered deuterium-containing Pd plates. We in particular directly apply a bias voltage across the Pd sample to provide a current injection through Pd, to stimulate the nuclear reaction by Joule heating, also anticipating strong electrodiffusion or electromigration, in addition to the conventional deuterium diffusion induced by pressure/mass-concentration and thermal gradients.

Our experimental setup is a gas-phase, clustered reactor system [1,2]. A high-resolution small-amu quadrupole mass spectrometer, a gas proportional neutron detector, and a Geiger-Mueller detector for α, β, and γ rays are equipped to the facility. We first annealed a bulk Pd plate in an external furnace to degrease the surface. A Au film was then deposited on one side of the Pd plate, as a low-contact-resistance electrode as well as a capping layer to induce single-directional deuterium diffusion and desorption for the ease of analyses. The Pd plate absorbed deuterium asymptotically to the equilibrium, in a D_2 ambient of 760 Torr at room temperature. Electric current was then injected through a W needle contacted the Au-deposited surface of the Pd plate.

Figure 1 shows our typical experimental result. There are points of palladium-temperature increase with accelerations, despite the decrease in input power. Because the observed system is a deuterium-desorption process due to the palladium-temperature increase caused by the input power, the temperature should have relatively decreased based on the known chemical phenomena, since gas-desorption processes are endothermic. We did not observe such a rapid increase of temperature in the reference control runs without deuterium loading. Furthermore, even when the input power was smaller for the run with deuterium loading than that for the control without deuterium, the temperature attained with deuterium was higher despite containing an endothermic process of deuterium desorption. The temporal behavior of the heat generation is thus unable to be explained by known chemical processes. We have furthermore observed neutron signal peaks at timings corresponding to the accelerated temperature increases.

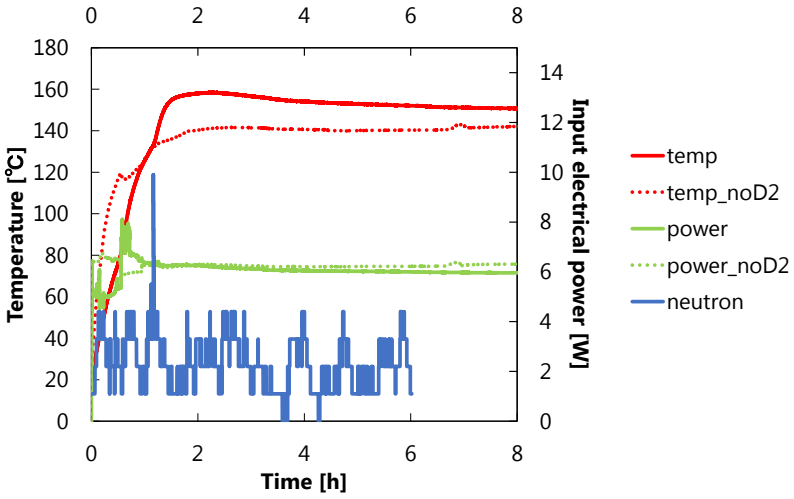

Fig. 1 Time evolution of Pd temperature and neutron signal.

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