Plasmonic Condensed Matter Nuclear Fusion

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The intensity and density of the triggering energy supplied to activate the nuclear fusion reaction are key factors to produce a smooth and reproducible initiation of the reaction. We previously proposed and numerically analyzed a scheme to provide high-density optical or electromagnetic energy to fusion-fuel materials by lasers and plasmonic field-enhancement effects, to significantly increase the reaction probability [1–6]. Large degrees of field enhancements, or energy focusing, were observed around metal nanoparticles and nanoshells [1], planar metal surfaces [2,3], metal/oxide interfaces [5], sharp metal tips [4], and metal nanogaps [6]. Strikingly, the field enhancement factors for hydrogen-absorbing transition metals, Pd, Ti, and Ni, can surpass those for noble metals in the microwave region [3,4]. This electromagnetic boosting effect may have unconsciously benefited the experiments reported so far, particularly for the electrolysis-type ones, and its active utilization with proper choices of materials, structures, and operating conditions can improve condensed-matter fusion systems further.

Gas-phase experimental research in quest of condensed-matter fusion is underway by using multilayered deuterium-containing Pd plates. In our experiment, 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. We installed multiple kinds of lasers in the gas-phase D–Pd reaction system to irradiate the Pd samples coated with noble metal nanoparticles, as energetic stimulation support, potentially with a boosting plasmonic local field-enhancement effect. We simultaneously observed a sudden temperature increase with an overshoot and a neutron signal. Significantly, we observed a clear signal of substantial-amount ^{4}He generation from the Pd samples as a shoulder peak on the D_2 peak, and a possible ^{3}He signal, via in-situ mass spectroscopy [7]. We also observed a sudden burst of these gas species out of the Pd sample. Our results might indicate a certain anomalous nuclear-related reaction in the D–Pd system.

This work was financially supported, in part, by the Thermal & Electric Energy Technology Foundation, the Research Foundation for Opto-Science and Technology, and the Japan Society for the Promotion of Science.

[1] K. Tanabe, "Plasmonic concepts for condensed matter nuclear fusion," *ICCF-20*, X-4, 2016 / *J. Cond. Matter Nucl. Sci.* **24**, 296, 2017.
[2] K. Tanabe, "Plasmonic field enhancement on planar metal surfaces for condensed matter nuclear fusion," *J. Cond. Matter Nucl. Sci.* **27**, 152, 2018.
[3] N. Fukuoka, K. Tanabe, "Large plasmonic field enhancement on hydrogen-absorbing transition metals at lower frequencies: Implications for hydrogen storage, sensing, and nuclear fusion," *J. Appl. Phys.* **126**, 023102, 2019.
[4] N. Fukuoka, K. Tanabe, "Lightning-rod effect of plasmonic field enhancement on hydrogen-absorbing transition metals," *Nanomaterials* **9**, 1235, 2019.
[5] K. Tanabe, "Plasmonic field enhancement at oxide/metal interfaces for condensed matter nuclear fusion," *J. Cond. Matter Nucl. Sci.* **31**, 1, 2020.
[6] Y. Nakashima, K. Tanabe, "Nanogap plasmonic field enhancement on hydrogen-absorbing transition metals," *Int. J. Hydrogen Energy* **46**, 14581, 2021.
[7] T. Uchikoshi, S. Ono, Y. Nakashima, Y. Kitagawa, K. Tanabe, "Laser condensed-matter fusion experiments," *ICCF-22*, H-4, 2019.