Hybrid Fusion-Fission Reactor Using Pd/D Co-deposition

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Earlier, we reported on observing the production of energetic particles during Pd/D co-deposition [1, 2]. The energetic particles produced include ≥ 1.8 MeV protons (including 15 MeV protons), ≥ 7 MeV alphas, 2.2-2.5 MeV neutrons, and secondary particles from either energetic protons and/or neutrons. We have also reported on observing the production of ≥ 9.6 MeV neutrons [3]. Such particles are energetic enough to fission uranium. Experiments were conducted in which Pd/D co-deposition was done on a composite cathode comprised of Au wire wrapped around a native uranium wire. The composite cathode was in contact with a CR-39 detector. Real-time gamma ray measurements were conducted during the course of the experiment. Changes in the baseline of the spectra and the shapes of the lines indicated that neutrons were generated, at a sufficient flux, to damage the detector. Neutron elastic scattering by Ge nuclei was modelled and the average energy of the neutrons was estimated to be 6.3-6.93 MeV. This was corroborated by the CR-39 results which showed the presence of triple tracks, Figure 1, that are diagnostic of the carbon breakup reaction, $^{12}C(n,n')3\alpha$, which has an energy threshold for the neutron of 9.6 MeV [3]. The presence of fission tracks, Figure 2, indicated that fissioning of uranium had occurred. This was verified by post-analysis using HPGe measurements in a Compton-suppressed Pb cave and liquid scintillation measurements of the spent cathode. The results of these experiments show that a hybrid fusion-fission reactor is feasible that would not produce greenhouse gases, could be easily shut-off, and could potentially be used to dispose of long-lived radioactive fission products produced by conventional nuclear power plants.

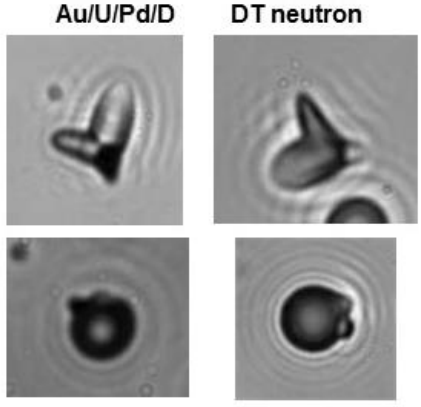

Figure 1. Examples of triple tracks observed in Pd/D co-deposition done on a Au/U cathode and their corresponding DT neutron tracks.

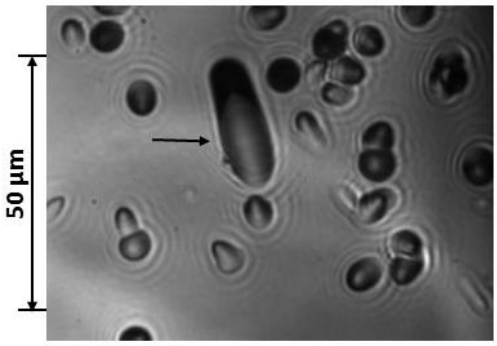

Figure 2. Fission track (arrow) observed in a CR-39 detector in contact with a Au/U/Pd/D composite cathode.

[1] P.A. Mosier-Boss, F.E. Gordon, L.P. Forsley, D. Zhou, "Detection of high energy particles using CR-39 detectors Part 1: results of microscopic examination, scanning, and LET analysis," Int. J. Hydrogen Energy, vol. 42, no. 1, pp. 416-428, 2017

[2] A.S. Roussetski, A.G. Lipson, E.I. Saunin, F. Tanzella, M. McKubre, "Detection of high energy particles using CR-39 detectors Part 2: results of in-depth destructive etching analysis," Int. J. Hydrogen Energy, vol. 42, no. 1, pp. 429-436, 2017

[3] P.A. Mosier-Boss, S. Szpak, F.E. Gordon, L.P.G. Forsley, "Triple tracks in CR-39 as the result of Pd/D co-deposition: evidence of energetic neutrons," Naturwissenschaften, vol. 96, no.1, pp. 135-142, 2009.