Muon Catalyzed d-t Fusion in Non-equilibrated Mixtures of T_2 with Normal, Ortho and Para-rich D_2

K. Ishida[a] T. Matsuzaki[a], H. Imao[a], Y. Matsuda[a], M. Iwasaki[a], K. Nagamine[a,b,c], N. Kawamura[b], M. Kato[d], H. Sugai[d], A. Uritani[e], H. Harano[e], T. Matsumoto[e] and G.H. Eaton[f]

[a] *RIKEN, Wako 351-0198, Japan*

[b] *High Energy Accelerator Research Organization (KEK), Tsukuba 305-0801, Japan*

[c] *University of California, Riverside, CA 92521, USA*

[d] *Japan Atomic Energy Agency (JAEA), Tokai 319-1195, Japan*

[e] *Institute of Advance Industrial Science and Technology (AIST), Tsukuba 305-8568, Japan*

[f] *Rutherford Appleton Laboratory (RAL), Oxon OX11 0QX, UK*

It is predicted that the $dt\mu$ molecular formation rate in D/T mixture, and thus the μCF cycling rate, is very much dependent on the ortho-para ratio of the D_2 molecule[1] because the ratio influences the population of even and odd initial rotational molecular states in the resonant reaction. We performed the first measurement for the three different mixtures of D_2(normal)/T_2, D_2(ortho)/T_2 and D_2(para-rich)/T_2 at the RIKEN-RAL Muon Facility by using the ortho-para D_2 production technique developed for dd-μCF experiments[2, 3], In the measurement, pure T_2 and pure D_2 were prepared separately and was mixed to make a liquid target of 20 K. The cycling rate λ_c was monitored for the duration of more than 100 hours after D_2+T_2 mixing. The λ_c decreased with time after mixing in all three cases, which can be attributed to the equilibration due to the molecular recombination as well as the ortho-para D_2 conversion in the target. We observed difference in λ_c value among the three mixtures in the early time region. Surprisingly, the observed effect in the liquid targets was opposite to the first theoretical prediction based on the isolated molecules[1]. A preliminary analysis shows that λ_c is larger by about 7 %, in D_2(ortho)/T_2 compared with that in D_2(normal)/T_2. while it is smaller in D_2(para-rich)/T_2.

---

[1] M. Leon and J.S. Cohen, Phys. Rev. A **31**, 2680 (1985).

[2] A. Toyoda *et al*, Phys. Rev. Lett. **90**, 243401 (2003).

[3] H. Imao *et al*, Phys. Lett. **B632**, 192 (2006).