MECHANISM OF NEUTRON EMISSION DURING FRACTURE OF DEUTERATED TITANIUM

B.P.Chandra, M.H.Ansari, S.Tiwari and M.S.K.Khokhar
Department of Postgraduate Studies and Research in Physics, Rani Durgavati Vishwavidyalaya, Jabalpur 482 001

Recent experiments on the emission of neutrons substantially above the background, during violent mechanical action on heavy ice and lithium deuteride have indicated the occurrence of a nuclear reaction /1,2/. For explaining the observations of fusion accompanying electrochemical loading of deuterium into Pd and Ti, several workers have proposed a mechanism leading to a D+D fusion reaction involving crack propagation in the embrittled materials. It has been anticipated that the high electric field produced near the tip of mobile cracks is responsible for the fracto-fusion mechanism /3/. However, the reason of the electric field produced at the mobile crack-tip is unknown todate. The present paper reports on the mechanism of fusion during fracture of deutrated titanium.

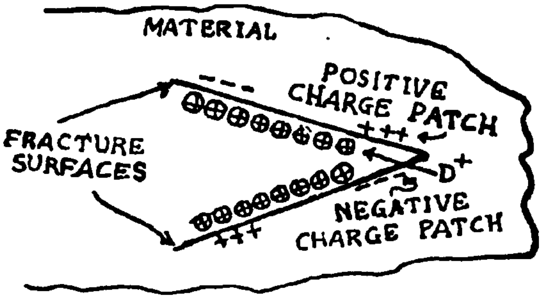

Fig.1. Schematic of fracto-fusion model.

Fig.1 shows the schematic diagram of the fracto-fusion model where a propageting crack produces separation of charge and releases D^+ ions which accelerates in the resulting electric field. Since Ti metal has HCP structure and belongs to $I6_3$/mmc space group, the surface charging may not be due to the piezoelectrification. As Ti is a conductor, there is no possibility of charged dislocations and production of electric field during their motion. It seems that when the crack propagates in a metal, a non-equilibrium will be created which may cause different Fermi levels at both surfaces and in turn local charging may take place. Since there is very high temperature and high pressure near the tip of mobile cracks, the newly created surfaces may behave differently as compared to the conductor and as such fast decay of surface charges may not be possible.

The experimental observations on the radio frequency emission and fracture-generated currents strongly suggest charge separation during fracture of Ti metals. It seems that crack growth results in charge separation in the newly formed crack surfaces, which act like a miniature "linear accelerat- or" i.e. D^+ ions are accelerated in the electric field across the crack tip to kinetic energy of 10-10^4 eV or more, sufficient to raise significantly the D+D fusion probability.

Although stochastic distribution of charge on the fracture surfaces of metals is possible, high conductivity should result in decay times on the order of 10^{-14} second, which will make charge acceleration in the crack unlikely. The longer decay time might result from crack geometry. Perhaps more importantly, impurity segregation and the existence of inclusions in commer- cial metals and alloys, may result in interfaces and insulating surface layers that simultaneously induce strong charge separation and inhibit reneutralization at separating fracture surfaces for considerably longer times.

/1/ V.A. Klyuev et al, Sov. Tech. Phys. Lett 12, 551 (1987)
/2/ B.V. Deryagin et al, Kolloidnii Zhurnal, 48, 12 (1986)
/3/ T. Takeda and T. Takizuka, J. Phys. Soc. Japan 58 (1989) 3073-76