# Low-energy nuclear reactions in metals

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In order to investigate the interplay between nuclei and their surroundings, we have studied deuteron induced fusion reactions in metals for bombarding energies lower than 80 keV. So far, we have studied (1) reaction rates of the DD fusion reactions and branching ratios R = Y(DD n+$^{3}$He)/Y(DD p+T) as a function of the deuteron energy for $E_d$ < 12 keV in various metals, (2) reaction rates of the $^{6,7}$Li(d,a)$^{4,5}$He reactions as a function of the deuteron energy in Pd and Au metal for bombarding energies between 30 and 75 keV. (3) Energetic proton (up to 17 MeV) and a-particle (up to 6 MeV) emissions during deuteron bombardments on metals.

The results of the measurements (1) clearly showed that both the D+D and Li+D reactions are strongly affected by the environments surrounding the nuclei; reaction rates depend on the metal host very strongly. The enhancement can be parameterized by introducing the screening energy. For the DD reaction, the most enhanced reaction so far observed is in PdO; the screening energy of about 600 eV. In Pd, Fe and Re, the DD reaction is enhanced but not so large as in PdO; the screening energy of 200 300 eV. In other metals such as Be, Ti, Ni, Cu, Sm and Au the DD reaction is not enhanced or slightly enhanced; the screening energy of about 100 eV or less. The Pd metal also provides strong enhancement on the reaction rate for the LiD reaction and the screening energy is about 1600 eV in Pd. On the other hand, it is not enhanced in Au at all; the screening energy of about 60 eV.

The large values of the screening energy for the DD and LiD fusion reactions cannot be explained by the screening due to the conduction electrons in metal, and, thus, strongly suggest the existence of another important mechanism to enhance the fusion reactions in metal. We suggest the possibility of a dynamic screening mechanism during the deuteron bombardment and penetration into the host wherein the fluidity of deuterons must play a decisive role.

The results of the measurements (3) have suggested that nuclear reactions involving three deuterons occur in metals. Although most of the energetic protons and a particles can be explained by sequential reaction processes, there exist excess yields which can be interpreted as emitted in a direct reaction process.