

On the Mechanism of Realization of Low-Energy Nuclear Reactions in Low-Temperature Plasma

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Earlier it was shown [1. 2] that the mechanism of the implementation of low-energy nuclear reactions (LENR) in a low-temperature plasma (under conditions of a glow discharge, during laser ablation of metals in aqueous media) can be understood on the basis of the concept of the existence in nuclear matter of non-nucleon metastable excitations initiated by high electrons (in terms of chemical scales) energies of the order of 3-5 eV. Specifically, we are talking about the formation of sufficiently long-lived (~ 10 minutes or more) light neutral nuclei – β -neutron and β -dineutron, respectively, with a disturbed nucleon structure (the states of “inner shake-up” or isu -state), under conditions of a non-equilibrium low-temperature protium- or deuterium-containing plasma [2]. In the absence of Coulomb barriers, these nuclei effectively participate in nuclear chemical processes, forming compound nuclei with target nuclei, in which the nucleonic structure is also disturbed. The latter factor determines the relaxation of the excitations of compound nuclei during their decay (with the formation of products) not by the emission of quanta, but by the URCA process - by the emission of neutrino-antineutrino pairs that are safe for the environment. The literature data [3] are presented, independently indicating the possibility of existence in the discharge chamber of the plasma vortex reactor (gas flow- water steam) of neutron-like nuclei, which may turn out to be the ${}^1n_{isu}$ particles whose mass is 0.78 MeV less than the mass of a neutron. Indeed, according to [3], neutron-like nuclei are recorded as neutrons on proportional He-3 detectors, but the test reaction for neutrons of initiation of artificial radioactivity of indium by streams of these particles gives a negative result. We see the reason for this result in the fact that the formation of a compound nucleus In with a neutral ${}^1n_{isu}$ nucleus with a disturbed nucleon structure complicates the “necessary” rearrangement of the nuclear matter of a compound nucleus, the relaxation of which will be more naturally realized through the emission of $\nu\bar{\nu}$ pairs, and not γ -quanta, as it is realized in the case of a well-defined nucleonic structure of excited nuclei.

In this work, within the framework of the concepts being developed, the results of the initiation of artificial radioactivity of impurity elements Pt , Pb in the Pd -cathode and Fe , Cu , Zn in the Ni -cathode, as well as of a significant reduction in the amount of these impurity elements in the cathodes and of the formation of the W -isotopes in the Pd -cathode [4].

[1] Timashev Serge. “On mechanisms of low-energy nuclear-chemical processes”, RENSIT, vol. 9, no. 1, pp. 37-51, 2017; [http://en.rensit.ru/vypuski/article/200/9\(1\)37-51e.pdf](http://en.rensit.ru/vypuski/article/200/9(1)37-51e.pdf)

[2] Timashev S. “Metastable Non-Nucleonic States of Nuclear Matter: Phenomenology”, Phys. Sc. Int. J, vol. 15, no. 2, pp. 1-25, 2017; <http://www.sciencedomain.org/issue/2727>

[3] Klimov A.I. at all “Neutron flux and soft X-radiation created by hetero-geneous plasmoid”, J. of Phys.Conf. Series, 19th Int. Workshop MPA, vol. 1698, p. 012034, 2020.

[4] Savvatimova I.B., Poteshin S.S., Kargin N.I., Sysoev A.A., Ryndya S.M., Timashev S.F. ICP MS in the analysis of the phenomenon of low-energy nuclear reactions initiated in metals under the conditions of a glow discharge”, Modern means of plasma diagnostics and their application. Collection of abstracts of the XII conf., Moscow, NRNU MEPhI, December 16-18, 2020, p. 133-136