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ANEUTRONIC PROTON-BORON FUSION IN OSCILLATING PLASMAS OF VACUUM DISCHARGE *)

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Earlier, experiments on the aneutronic proton-boron (pB) fusion p + 11B → α + 8Be* → 3α + 8.7 MeV in a plasma of a miniature nanosecond vacuum discharge (NVD) were presented [1]. In the cylindrical geometry of the NVD, a well-known inertial electrostatic confinement (IEC) scheme, but with reverse polarity, was implemented [1]. In this scheme, PiC modeling in the electromagnetic code KARAT revealed the formation of a virtual cathode (VC) in the anode space of the NVD and a corresponding potential well (PW) with a depth of ≈ 100 kV. A quasi-stationary PW with a size of several millimeters plays the role of a micro-accelerator of protons and boron ions to energies of hundreds keV, when the yield of the pB reaction in the field of particle energies near the secondary resonance (≈ 150 keV) becomes already noticeable [1]. In the process of ion oscillations in PW, head-on collisions of a part of protons and boron ions with energies of ~100-500 keV lead to a proton–boron reaction and the appearance of α particles [1]. In the same scheme of deuteron confinement and oscillations in the PW, nuclear DD synthesis was previously studied, where both a single and pulsating yield of 2.45 MeV neutrons was observed [2].

In this paper, the yield of α-particles in further experiments on pB fusion is discussed, as well as the features of oscillatory confinement in NVD as a relatively new type of inertial plasma confinement [1]. PiC modeling of pB synthesis processes showed that the plasma in the NVD, and especially on the discharge axis, is in a state close to quasi-neutral, which is markedly different from the conditions in the well-known scheme of periodically oscillating plasma spheres (POPS) [3,4]. This scheme was proposed for thermonuclear fusion in oscillating plasma, but, in particular, due to limitations on the compression ratio, it was not further developed [5]. Unlike the coherent compressions in the original POPS scheme, it seems that small-scale oscillations in the NVD are the mechanism of resonant ion heating. Nevertheless, the favorable scaling of the nuclear fusion power with a decrease in the radius of the VC [3,4] is preserved for NVD also, but at the same time it differs markedly both in the compression ratio and in the values of the quasi-neutrality parameter [6]. In addition, unlike the POPS scheme, where the plasma is considered to be in equilibrium, PiC simulation shows that the distribution functions of protons and boron ions in the NVD are not Maxwellian. Thus, in the studied IEC scheme with reverse polarity based on NVD, both DD synthesis and aneutronic pB synthesis take place in a nonequilibrium plasmas remaining "non-ignited" on the discharge axis [6].

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