

Stimulation of Re-186m isomeric nuclei de-excitation in high-current Z-pinch plasma at the “Angara-5-1” facility

Tuesday 2 July 2024 16:40 (20 minutes)

Recently, in a laser plasma with an average electron temperature $\Theta \sim 1$ keV and a lifetime $\tau \approx 0.3$ ns, it was found out the stimulation of de-excitation of nuclear isomers (SDENI) Re-186m (half-life $T = 2 \times 10^5$ years) to the ground state of the Re-186 nuclei ($T = 90$ hours) with a probability $P \approx 1 \cdot 10^{-7}$, which apparently occurred through an intermediate trigger level with a half-life of ~ 10 days. To increase the SDENI probability, it was proposed to use longer-lived electric discharge plasma instead of laser plasma (see Ref. [1] and references in there).

In Ref. [2], a methodology for SDENI experiments was developed for Re-186m isomers in the Z-pinch plasma of the “Angara-5-1” facility at Troitsk Institute for Innovation and Fusion Research. Plasma was obtained by implosion of a two-cascade cylindrical multiwire assembly (liner) with a current pulse of 4 MA and 1 MV voltage passing through it. The outer cascade of the liner with a diameter of 12 mm and a linear mass of 300 $\mu\text{g}/\text{cm}$ was composed of Al-wires with a diameter of 8 μm , and the internal cascade with a diameter of 6 mm and a linear mass of 20 $\mu\text{g}/\text{cm}$ was made of W-wires of 6 μm diameter. A Re-layer of 0.5 μm thick with the Re-186m isomer was deposited on W wires by electrolysis. The first experiments showed a SDENI-induced disturbance of the radioactive equilibrium between the isomer and the ground state of the Re-186 nucleus in Z-pinch plasma at $\Theta = 400$ eV and $\tau = 10$ ns. The intensity I of 137 keV γ -quanta of Re-186 decay from a sample of plasma matter after three plasma shots, decreased with time t and reached its stationary value after $t \approx 40$ days. Based on the parameters of the $I(t)$ time dependence, we estimated the SDENI probability of $P \approx 2 \cdot 10^{-7}$ in the plasma. The work was supported by the Private Enterprise “Science and Innovations” (ROSATOM) (contract No. 774/569-D).

1. V. Koltsov // “On the stimulation of the de-excitation of nuclear isomers in plasma of a high-current electric discharge”. Plasma Phys. and Techn. 2021. V. 8(1). P. 5.
2. G.S. Volkov, E.V. Grabovski, A.N. Gritsuk, V.V. Karasev, V.V. Koltsov // “On the possibility of observing stimulated de-excitation of nuclear isomer Re-186m in a high-current Z-pinch plasma at the Angara-5-1 setup”. Phys. At. Nucl. 2022. V. 85(9). P. 1486.

Section

Experimental and theoretical studies of nuclear reactions

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Session Classification: Experimental and theoretical studies of nuclear reactions