Acceleration of mm-sized bodies in an electromagnetic rail accelerator with a plasma armature

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At present, electromagnetic rail accelerators find a wide use in various fields of science and technology [1-3] for accelerating bodies to hyper-speeds (for high-speed collision research or for injecting fuel into a thermonuclear reaction zone, etc.), generating high-speed plasma jets with various chemical compositions (for coating sputtering).

This report presents the results of experimental and theoretical studies aimed at determining the limiting characteristics of the acceleration of a plasma armature with a solid body in front of it or a free plasma armature in an electromagnetic rail accelerator with an external magnetic field.

The investigations were carried out for the railgun channel filled with different gases (air, helium, argon, xenon) under different pressures. The goal was to study the influence of external factors on the acceleration characteristics. It was found that, starting from a certain speed, the free (without a solid body in front of it) plasma armature in the channel was no longer accelerated and its speed became constant. This can be explained by the fact that the gas behind the shock wave in the channel became conductive, and some of the electric current that had previously been spend on the acceleration of the plasma armature began to flow in front of it, which had a significant effect on the acceleration efficiency.

The dependence of the achievable velocity on the pressure, gas type in the channel of the railgun accelerator, and the mass of the accelerated body for the case of solid impactor acceleration was obtained.

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