Generation of the characteristic x-rays under the vacuum heating of electrons near the surface of the nanocylinders

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Increase of the conversion efficiency of short laser pulse energy into the narrow-band x-ray emission using nanostructured targets is topical for various applications, including diagnostics of dense plasmas.

This paper investigates the yield of Kα photons from a copper foil under the vacuum heating of electrons by the laser field near the surface of ionized gold nanocilinders, arranged on the foil obliquely and parallel to each other. When the laser field is perpendicularly incident on the foil, the electrons are accelerated by a component of the electric field, normal to the “illuminated” surface of each cylinder. Then they return into the cylinder to get out of its “shadow” surface and fall onto the foil. Impact ionization of the K-shell of foil’s atoms leads to emission of Kα radiation.

It is shown that absorption of the laser field energy by accelerated electrons should be taken into account to determine the maximum value of the accelerating field on the cylinder surface. The maximum value of the accelerating field is obtained when the laser field is polarized in the plain formed by the axis of the cylinder and the wave vector. In this case, the influence of the field near the “shadow” surface of the cylinder on the accelerated electrons can be neglected. The maximum yield of Kα radiation is reached with the angle of obliquity of the cylinders and the ratio between their diameter and the wavelength, which correspond to the maximum value of the accelerating field. The geometrical characteristics of the target, in which the x-ray yield increases by more than an order of magnitude compared to using the target covered with closely packed spherical clusters [1], are determined.

References

1. Kostenko O.F. Quantum Electronics (2014). V. 44, No. 5. P. 478.