Laser centrifugal atomization

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The highest quality spherical powders are produced by centrifugal atomization. On an industrial scale, the PREP (plasma rotating electrode process) method is used, in which the melting of the end of a rotating cylinder is carried out by a plasmatron. The method has significant disadvantages – high energy costs, the inability to obtain powders smaller than 30 microns. The new method – laser centrifugal atomization (LCA) and systems for its implementation have developed, which allow us to overcome these shortcomings. In new method, the end of a rotating hollow cylinder with a wall thickness of 4 mm is melted by a system of several lasers, whose focal spots with a diameter of, for example 2 mm are located evenly around the perimeter of the cylinder. When the cylinder rotates, a pulse-periodic mode of action is implemented for each point of the end.

When exposed in a pulse-periodic mode, the average power density of laser radiation is determined during long-term heating $t >> r^2 / 4 \cdot a$ (r – radius of focal spot, a – thermal diffusivity) according to the relation:

$$A \cdot q_b = \lambda \cdot T_b / r \ - \text{ for boiling;} \quad A \cdot q_m = \lambda \cdot T_m / r \ - \text{ for melting,}$$

$V = \pi \cdot D \cdot n$ – velocity of focus spot, A – absorptivity, n – rotation frequency, D – diameter of cylinder.

Calculations of the processes of melting and evaporation of the end of a rotating hollow cylinder with a diameter of 5 cm at a speed of 170 rp/s were carried out under the influence of 4 lasers with a power of 10 to 40 kW.

Atomization of the melt is carried out in an atmosphere of inert gas. And atomization of an erosion plume or erosion plasma is carried out under conditions of vacuum or reduced pressure.

The results of calculations show that the productivity of obtaining powders from the melt (size 30-200 microns) will be up to 500 kg/h with an efficiency of 0.41 kWh/kg, and nanoparticles from the vapor plume or plasma – up to 150 kg/h with an efficiency of 0.87 kWh/kg.

Since the plume of vapor (plasma) is deflected by centrifugal force, the restrictions on the power of laser radiation associated with shielding the target are removed.