EFFICIENCY OF SYNTHESIS OF CERAMIC MATERIALS UNDER THE INFLUENCE OF AN ELECTRON BEAM WITH HIGH PENETRATION*

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A number of works carried out in recent years, for example [1, 2], have shown the effectiveness of the method of forming luminescent ceramics in an electron beam with an energy of 1.4 – 2.5 MeV released into the atmosphere. This works was carried out at the UNU Stand ELV-6 installation at the Budker Institute of Nuclear Physics SB RAS. The penetration depth of a beam of the specified electron energy corresponds to the mass thickness of the processed material 0.6 – 1.2 g/cm^2. The formation of ceramics is made from the original powder material placed in a massive copper crucible.

The present study compares the energy required to form ceramics h_{melt} and the energy actually expended by the electron beam in this process. The authors determined the energy required to form ceramics from thermodynamic reference books, neglecting the contribution of radiation processes and assuming that ceramic synthesis was liquid-phase.

The efficiency of forming ceramics from the initial powder material η is determined as

$$\eta = \frac{h_{melt}}{w}, \tag{1}$$

where h_{melt} is the enthalpy of formation of a unit of mass of ceramics from room temperature to the completion of melting, w is the energy released by the beam in this unit of mass.

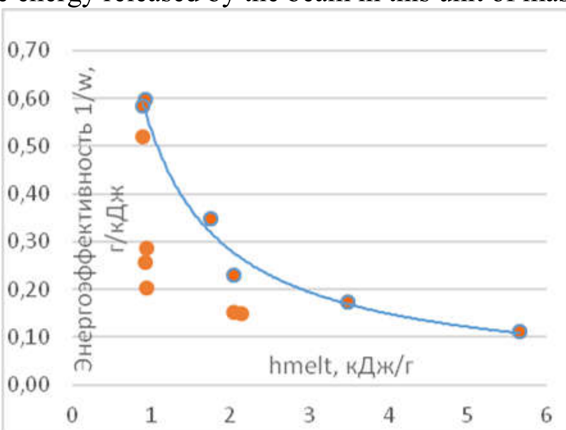

Fig. 1. Energy efficiency of forming two-element ceramics from initial powders of different composition and dispersion.

One can found that, regardless of the melting temperature of the ceramic and the amount of energy required to bring it to melting h_{melt}, there are modes of ceramic formation with high efficiency, close to 60%. On the graph Fig. 1 points correspond to several modes of formation of ceramics consisting of two elements. The vertical axis represents energy efficiency, which shows how much ceramic mass is produced by the electron beam when a unit of beam energy is injected into the material. The energy efficiency determined in this way is equal to 1/w and is expressed in g/kJ. The maximum efficiency values η = 0.6 correspond to the mode envelope in the form of a hyperbola.

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