C2-P-936201

THE INFLUENCE OF PULSED ELECTRON BEAM IRRADIATION ON THE STATE OF ZRN COATING/SILUMIN SUBSTRATE SYSTEMS*

P.V. MOSKVIN[1], *N.N. KOVAL*[1], *T.V. KOVAL*[2], *O.V. KRYSINA*[1], *YU.F. IVANOV*[1], *A.D. TERESOV*[1], *MY KIM AN TRAN*[3], *N.A. PROKOPENKO*[1], *E.A. PETRIKOVA*[1]

[1]*Institute of High Current Electronics SB RAS, Tomsk, Russia*
[2]*Tomsk Polytechnic University, Tomsk, Russia*
[3]*Ton Duc Thang University, Ho Chi Minh City, Vietnam*

A eutectic silumin was subjected to a combined treatment, including the deposition of a ZrN coating on a silumin substrate and the treatment of the coating/substrate system with a pulsed electron beam of submillisecond duration. Examination of thin transverse sections of the ZrN-coated silumin performed after electron beam treatment revealed an extended melt zone, the thickness of which was 30–55 μm for all samples. In the melt zone of the samples with coatings of thickness 0.5–2 μm irradiated with five electron beam pulses, a partial immersion of the coating into the bulk substrate to a depth of 45 μm was observed. Local measurements of the temperature in the electron beam treatment zone, numerical modeling of the fast heating (within 150 μs) and solidification of the melt under the action of an intense heat source were carried out for the action of experimental electron beam pulses (1.8×10^9 W/cm^2) on the bare and the ZrN-coated silumin. It was found that when the coating thickness was increased from 0.5 to 2 μm, the rise rate of the surface temperature increased from 6×10^7 to 9×10^7 K/s and the maximum temperature during the pulse rise increased from 760 to 1070°C (fig. 1). The melt depth was no more than 57 μm. The speed of the melt front during the pulse was 3×10^5 μm/s. The numerical simulation has shown that the eutectic temperature was not achieved at depths over 55 μm. Comparing numerical calculations and measurements of the surface temperature of materials subjected to electron beam treatment, it is possible to elucidate the dynamics of the temperature field and melt depth in order to attain predetermined properties of materials upon electron beam treatment. It should be emphasized that the pulsed electron beam with unique parameters we used made it possible not only to trace in detail the dynamics of changes in the temperature of the molten surface layer of a ZrN-coated silumin sample, but also to produce a rather extended (tens of micrometers) modified structure. According to preliminary estimates, such a modified structure of the surface layer of a product made of silumin should significantly improve its operational properties. The results obtained are important for the development of technology for pulsed electron beam modification of the structure and surface properties of silumin products used in modern industry.

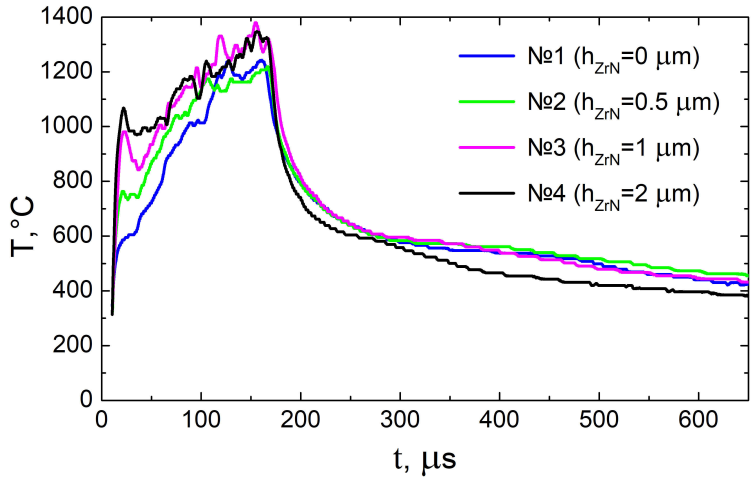

Fig.1. Time variations of the local surface temperature during electron beam treatment for the bare and ZrN-coated silumin sample (experiment).

* This research was funded by the Ministry of Science and Higher Education of the Russian Federation (FWRM-2021-0006); by the Russian Foundation for Basic Research and ROSATOM according to the research project № 20-21-00111.