MODELLING OF THERMAL DIFFUSION PROCESSES IN ELECTRON-PLASMA TREATMENT

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In order to strengthen the material surface, the combined treatment method matching the electro-explosive alloying and the sequential irradiation of electron beam is applied in effect.

The electro-explosive alloying effects on material mechanical properties by modifying the structural phase state of the treated surface layer. The electron-beam posttreatment on the surface allows removing the dripping fraction of the powder material and controlling the concentration gradient of alloying element.

The surface electron-beam treatment comes with the diffusion of alloying element atoms into the material bulk. Energy characteristics (electron-beam power density and the number of action impulse) of the electron-beam treatment have a considerable influence on the material microhardness since its largest value owes to a specific range of alloying element concentration.

This work leads a mathematical modelling of electron beam treatment on metal surface layer after an electro-explosive alloying. Model includes the solving of the heat equation with a consideration of phase change and dependence of thermophysical coefficients on alloying element quantity and diffusion equation with coefficients depending on temperature.

This work also investigates the influences of electron-beam power density and number of action impulse on the gradient of copper concentration in steel exposed to electro-explosive alloying.

We obtained that at an electron-beam power density of 15 J/cm^2 the copper concentration gradient formed after electro-explosive alloying does not change practically. At a power density of 30J/cm2, the copper concentration reaches 7–10 wt% with a layer width of 14 µm. This range is optimal for microhardness of steel alloyed by copper based on experimental data.

Keywords: *thermal diffusion processes, electron-beam treatment, electro-explosive alloying, phase change.*

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