Dynamics of fusion and crystallization processes induced by nanosecond emission of ruby crystal laser in gallium arsenide and gallium antimonide

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Diversity of $A^{III}B^{V}$ semiconductors properties preconditions their expansive application in the instruments and devices. $A^{III}B^{V}$ semiconductors based injection lasers feature good efficiency of electrical power to electromagnetic conversion. GaAs is potentially one of the best photosensitive materials. For successful application of laser methods in modern technological processes of semiconductor materials treatment the data on the physical phenomena occurring if these semiconductors are subject to the laser emission. Some works covered modification regularities of GaAs top layers when subjected to laser pulses. However numerical simulation of fusion and crystallization was performed ignoring surface evaporation processes and diffusion of the components in the melt. Here there are provided the results of the numerical simulation fusion and crystallization processes in GaAs and GaSb induced by nano-second emission of ruby laser (λ = 694 nm, τ =80 ns) with account of surface evaporation and diffusion of the components in the melt). Waveform of laser pulse was set by function $\sin^2(\pi t/2\tau)$. The thickness of semiconductor wafer was assumed to considerably exceed the larger length of heat diffusion for the time of laser pulse and was taken equal to 38 μm. Numerical simulation was performed on the base of mathematical model provided in [1]. At the result of the simulation of laser-induced gallium arsenide surface modification with account of surface evaporation processes and diffusion of the components in the melt it is demonstrated that the process of arsenic atoms evaporation affects the dynamics of the phase transition at near – surface area. At the result of arsenic atoms evaporation and diffusion of gallium arsenide components in the melt there occur the gallium enrichment of the near-surface area. Using at simulation the dependences of crystallization temperature and latent heat of phase transition upon the components concentration in the melt allowed to obtain satisfactory conformity to the experimental data on the dependence of the maximum temperature of melt surface and life time of liquid phase upon the energy density. Simultaneously the process of the components evaporation in gallium antimonide under the impact produced by nano-pulse emission of ruby laser does not significantly affect the dynamics of the phase transitions in the near-surface area.

References

[1] Zhvavyi S.P., Urbanovich A.I., Zykiv G.L., Bulletin of Belarussian State University, Series 1, Issue1, 2010, p. 36.