AN AXISYMMETRIC INTERFACIAL TRACKING MODEL FOR MELTING-VAPORIZATION-RESOLIDIFICATION IN A THIN METAL FILM IRRADIATED BY PICO TO FEMTOSECOND PULSE LASERS

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ABSTRACT

A two dimensional axisymmetric, interfacial tracking method is developed to model rapid melting and solidification of a free standing metal film subjected to an ultra-short laser pulse. Finite volume method is employed to solve the coupled electron and lattice heat conduction equations together with the equations for ultrafast solid-liquid phase transformation, to calculate the location of solid-liquid interface and the temperature distribution in the metal film. The interfacial velocities, both melting and resolidification, in the ultra-fast phase change process are obtained by considering interfacial energy balance and the nucleation dynamics. Both the electron and lattice temperature in the metal film irradiated by Gaussian laser beams are computed and presented along the cylindrical coordinates. The effect of laser fluences and characteristic radii on melting and resolidification are also investigated.

A numerical procedure to analyze the vaporization of metal when interacts with ultrashort laser pulse is also developed. The temperature dependent thermal characteristics as well as electron-lattice coupling factor have been considered. An iterative procedure based on energy balance and gas kinetics law is implied to track the axisymmetric liquid-vapor interface, which in turn is utilized to obtain the material removal rate.