INTRODUCTION

Laser technology attains progressively more and more interests due to the ever increased applications in all fields of science ,engineering and medicine . High power lasers are already gaining acceptance in material processing areas such as spot welding , cutting , drilling of holes [1,2,3]. The very high power density of lasers and the realizable extreme small focus spots allow melting to be localized at well defined locations in the target. In material science lasers have found a lot of applications such as in producing p-n junction [4] as well as in plasma generation. In the field of communication , the laser beam in conjunction with the development of fiber optics has found a great application in information transfer. The most spectacular effects involving a change of phase of the absorbing material , have been investigated by Ready[5]. The advent of the laser has produced a light source of high power enough that considerable heating effects may be generated when light is absorbed. Thus the study of thermal effects of the laser on the solid target when the light is absorbed gives the required information to avoid damage of the irradiated surfaces as in case of laser mirrors and therefore to extend their life time [6-8]. Due to these applications the laser material interaction seems to be a very important field of investigation.

Since heating and damage caused by a laser beam are serious problemes , so they were subject of many investigations [5,10-21]. El-Dessouki et al. [22,23] have experimentally studied the thermal effect of lasers on glass substrate coated by different thin metal film of silver,copper , aluminum , nickel , chromium and antimony. They showed that the depressions are found to be greater than those produced in uncoated glass. Also they showed that the damage into the double layer target is four times greater than its value for the corresponding thickness in the single layer case , when the laser power pulse is kept constant. To be able to control the effects induced by absorption of a laser radiation , several authors attempted to solve the heat conduction equation in different target configurations for certain boundary conditions through different mathematical techniques. Nevertheless , the quantitative analysis of such problem still needs further trial at different conditions to obtain formula that can easily be computed in practical sense. Such trials are necessary to obtain a simple way to know more and more information about the damage process. A.F. Hassan et al. [19] have tried to solve the diffusion equation of the laser heating problem by suggesting a solution that satisfies the physical phenomena. El-Adawi et al. [14,24,25] have studied such problem theoretically by solving the differential and integral forms of heat equation using Fourier expansion technique.

The present analysis is oriented to solve the one dimensional heat transfer equation for a semi-infinite target and a thin layer coated on a semi-infinite substrate. Using the Laplace integral transform technique , the investigation is carried out considering surface absorption of the laser beam at the irradiated front surface of the target. For the heating process different temporal laser pulse profiles [26] such as square pulse , laser pulse shape with spikes , the profile measured by Ready , scalene triangle pulse , isosceles triangle , Gaussian pulse and multipulses of the type measured by Ready are used. In this study attention will be restricted to processes in which no plasma formation in front of the solid has been build up. All physical parameters of the target except , the surface absorptance , are considered to be temperature independent. Moreover it is assumed that the laser radiation is not accompanied by non-linear effects such as multiphoton absorption. Thermal losses at the front surface of the target is also taken into account. Under these assumptions mathematical expressions for the spatial temperature distribution within a semi-infinite target , thin layer coated on a semi-infinite substrate and the substrate as well as the time dependence of the temperature at the front surface of the target are obtained.

The problem of melting a thin-layer coated on a semi-infinite substrate up to the point of evaporation is studied under the conditions that the temperature along the molten layer thickness is kept constant at the phase change temperature during the melting process and to have a profile after full liquidification of the film. Mathematical expressions for the temperature distribution within the solid part of the film , the thickness of its liquidified part , the temperature distribution in the liquid after full liquidification of the film and the temperature distribution in the substrate are obtained.

As an illustrative example for the heating process computations are carried out on a semi-infinite Al-target and a thin Al-layer coated on a semi-infinite glass substrate. For the melting process computations are carried out only on a thin Al-layer coated on a semi-infinite glass substrate.