Abstract

The exact transient axis symmetry heat equation solution of temperature, stress and failure stress in a microchip laser crystal has been derived analytically through the analysis of integral transform method. The derived analytical solution could indicate the effect of each parameter on the solution. The effects of changing the convection heat transfer coefficients has been studied. It was found that increasing the face and edge cooling from 27.5 to 10000 $W/m^2.K$, reduce the overall temperature from 27.8 to 16.2 and thermal stress from 6.3 to 3.8 MPa was obtained within the microchip crystal. Furthermore, the effect of changing pump power with the face and edge cooling heat transfer coefficient have been studied, and it was found that increasing the pumping power will increase the overall temperature and thermal for all face and edge cooling values. The value of the optical path difference (OPD) and the thermal lensing within the microchip crystal were obtained by the derived equation. It was found that the increasing in the cooling rates has a small effect on the thermal focal length, while increasing the pumping power will decrease the thermal focal length within the microchip laser crystal.

The effect of using Gaussian pumping and top-hat pumping for different pumping radius were studied on the temperature, thermal stress and the thermal focal length. The difference between the Gaussian and top hat pumping with the same pumping radius was found to be small. It was found that increasing the pumping radius from 0.2 to 1.5 mm for the top hat reduced the temperature from 25.3 to 4.5 ^oC and thermal stress will be reduced while it will cause a huge increase in the thermal focal length within the microchip crystal pumping power due to decrease in the resulting temperature. It was found that top hat pumping causes failure in pumping power less than that of Gaussian pumping