APPLICATION NOTE

LASER DIODE COLLIMATION

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1. INTRODUCTION

The collimation of the highly divergent astigmatic beam coming from the laser diode requires a pair of cylindrical microlenses perpendicular to each other. Two distinct cylindrical lenses permit complete removal of the astigmatism inherent to laser diodes. This is accomplished simply by proper focussing of the lenses in each direction. The lens closer to the laser collimates the fast axis of the diode. This lens should have high NA to match the fast axis beam divergence. The other lens collimates the slow axis of the laser diode and normally does not require very high NA since the light from the laser diode in the horizontal plane is less divergent. To preserve a small beam diameter of the collimated beam, it is beneficial to use lenses with shorter focal length. However, smaller focal length generates higher beam divergence of the collimated beam and stiff positioning tolerances.

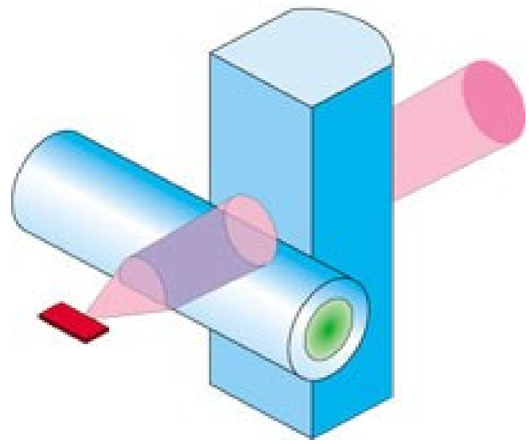

Figure 1. LD collimation

2. BEAM DIVERGENCE

As a remainder, the beam divergence of the collimated beam in two respective planes is defined as:

$$\textit{Fast axis divergence} = \arctan\left(\frac{(\textit{Laser width})}{(\textit{Fast axis lens focal length})}\right)$$

$$\textit{Slow axis divergence} = \arctan\left(\frac{(\textit{Laser length})}{(\textit{Slow axis lens focal length})}\right)$$

From these two expressions, the size of the laser window and required divergence in each direction, it is straightforward to calculate needed focal lengths of cylindrical lenses. It is obvious that the focal length ratio of the fast and slow axis collimators equals the aspect ratio of the laser's window. This is the main criterion when designing the laser diode collimators.

For example, the collimation of the 1 mm x 5 mm laser diode window to the same divergence in both directions requires the focal length of the slow axis collimating lens to be five times larger than the focal length of the fast axis lens. To follow this rule, the working distance of the slow axis collimator must be sufficiently large to accommodate for the fast axis lens.

The laser diodes or bars with a higher aspect ratio, typically 1 mm x 100 mm for each source, require much longer focal length of the slow axis collimator. The combination of gradient-index cylindrical lens and homogeneous plano-convex or double-convex lens can provide an effective collimating system for this kind of diodes or arrays.

Gradient-index cylindrical lens has been widely accepted as the fast axis collimating lens of choice. The lens has earned international market acceptance and recognition, thanks to its high numerical aperture, high optical quality and easy alignment. Meanwhile, for the collimation of the fast axis of laser diode arrays, the gradient-index microlens might be the only choice, the only lens to provide good collimation over the length of the laser diode bars (“smile”).

The same collimation technique is applicable to the light emitting diodes (LEDs).

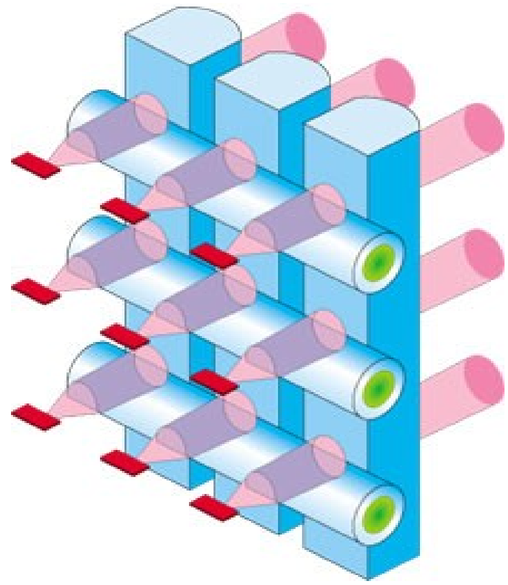

Figure 2. LD array collimation