UNIFORM IRRADIATION CONFIGURATION FOR SINGLE EMITTER LASER DIODES

The disclosed configuration overcomes the disadvantages of the prior art by providing a novel emitter which includes a plurality of single emitter laser diodes, arranged in a novel configuration produces irradiation with a wide angular distribution which is substantially uniform. Single emitter laser diodes are generally stable, exhibit a high MTBF, are easily modulated, produce substantially low amounts of heat which has to be evacuated and are substantially tolerant to temperature changes.

Single emitter laser diodes are do not exhibit an angular irradiation which is uniform. A single emitter laser diode is commonly addressed as having irradiation in a fast axis and in a slow axis, wherein these two axes are orthogonal to each other.

Figure 1 is an illustration of the irradiation angular distribution of a single emitter laser diode in the slow axis and in the fast axis. The irradiation angular distribution of the slow axis resembles a step function and the divergence thereof is roughly 12 degrees. The irradiation angular distribution of the fast axis resembles a Gaussian and the divergence thereof is roughly 35 degrees.

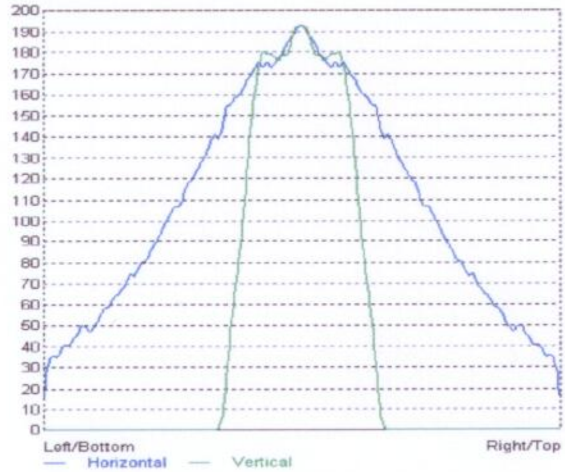

Figure 1

Figure 2 is a two dimensional illustration of the power/distance angular irradiation front of one single emitter laser diode, in the far field (i.e., at a distance of more than several centimeters from the diode). The different colors denote different levels of power. The fast axis of the single emitter diode is aligned with the horizontal axis of Figure 2. The slow axis of the single emitter diode is aligned with the vertical axis of Figure 2.

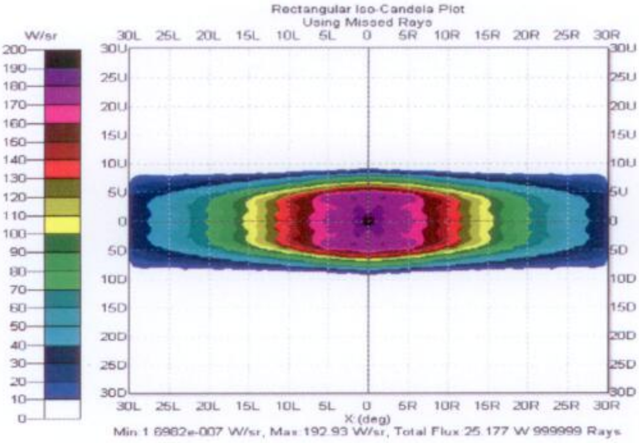

Figure 2

According to one configuration, the single emitter laser diodes are arranged in a manner wherein their individual beams overlap, such that the irradiation front of the irradiator is substantially uniform for a given spatial angle. Uniformity means that any point in space (i.e., within the given spatial angle) which is substantially far from the irradiator, shall receive light beams from several single emitter laser diodes, and that the combination of these beams at each such point, shall yield power which is substantially the same.

Figure 3 is an illustration of single emitter laser diode (SELD) configuration. This single emitter laser diode configuration includes a plurality of single emitter laser diodes $SELD_1$, $SELD_2$, $SELD_3$, $SELD_4$ and $SELD_N$. Figure 3 provides an illustration of the configuration of a group of single emitter laser diodes, in one axis, which for the purpose of explanation shall be referred to as the horizontal axis. It is noted that such a configuration can be rotated in any desired spatial direction.

As can be seen from Figure 3, each diode is oriented at a predetermined angle relative to other diodes adjacent thereto. Point in space, P, receives light substantially from three light beams A, B and C from single emitter laser diodes $SELD_1$, $SELD_2$ and $SELD_3$, respectively. Single emitter laser diode $SELD_2$ is oriented to face point P, directly, while single emitter laser diodes $SELD_1$ and $SELD_3$ are oriented at an angle with respect to point P. Accordingly, light beam B is produced by the center of the fast axis Gaussian irradiation of single emitter laser diode $SELD_2$ while light beams A and C are produced from the slopes of the fast axis Gaussian irradiation of single emitter laser diodes $SELD_1$ and $SELD_3$, respectively.

The describe single emitter laser diode configurations achieves a relatively constant illumination across a wide angle of coverage in the far field, by overlapping a plurality of Gaussian beams, which are specially arranged. Each beam is tilted by an angle which is the FWHM (i.e., full width at half maximum) of each individual beam. Such an arrangement essentially yields optimal uniformity, in the fast axis dimension.

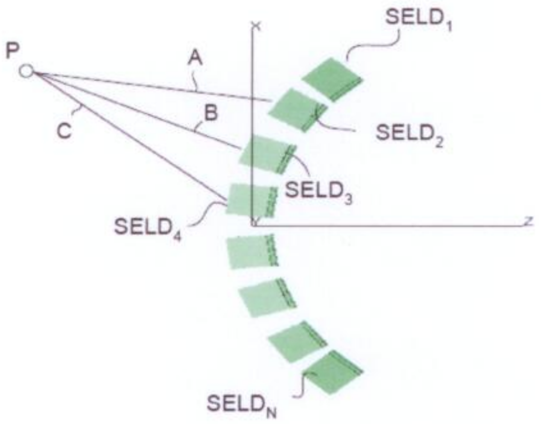

Figure 3

Figure 4 depicts another configuration of single emitter laser diodes. Figure 4 provides an illustration of the configuration of a complete two dimensional array single emitter laser diodes, in one axis, in both the horizontal axis and the vertical axis. As can be seen from Figure 4, each diode is oriented at a predetermined angle relative to other diodes adjacent thereto. Regarding the horizontal influence of adjacent single emitter laser diodes, point in space, P, receives light substantially from three light beams A, B and C from single emitter laser diodes, respectively. Regarding the vertical influence of adjacent single emitter laser diodes, it is noted that the single emitter vertical divergence is a result of a fast oscillating beam. This divergence is limited by the geometrical divergence inside the single emitter laser diode cavity.

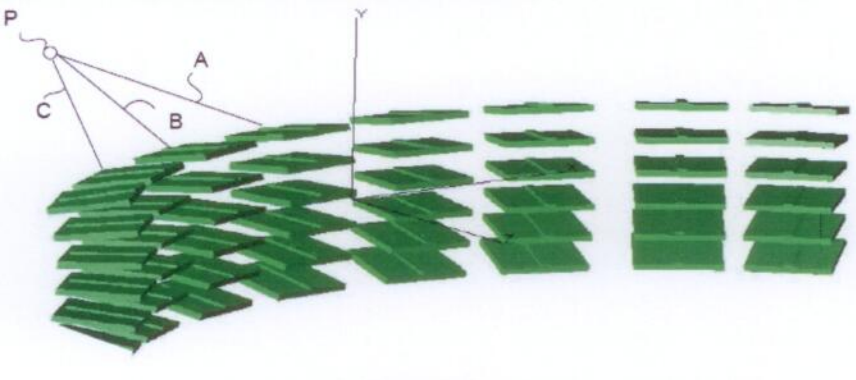

Figure 4

According to one two dimensional configuration of single emitter laser diodes, the vertical configuration of the single emitter laser diodes is without overlap (i.e., since the irradiation angular distribution of the slow axis, resembles a step function). Hence, the vertical (fast axis) portion of the beam coverage of one single emitter laser diode begins at substantially the same point where the vertical portion of the adjacent single emitter laser diode ends.

According to another two dimensional configuration of single emitter laser diodes, the vertical configuration of the single emitter laser diodes is half and hence, the vertical coverage of one single emitter laser diode begins at center point of the vertical dimension of the beam of the adjacent single emitter laser diode.

Figure 5 is an illustration of the power/distance irradiation front of the single emitter laser diode configuration of Figure 4. As can be seen from Figure 5, the variations in the irradiation power at various points in the irradiation front are minimal.

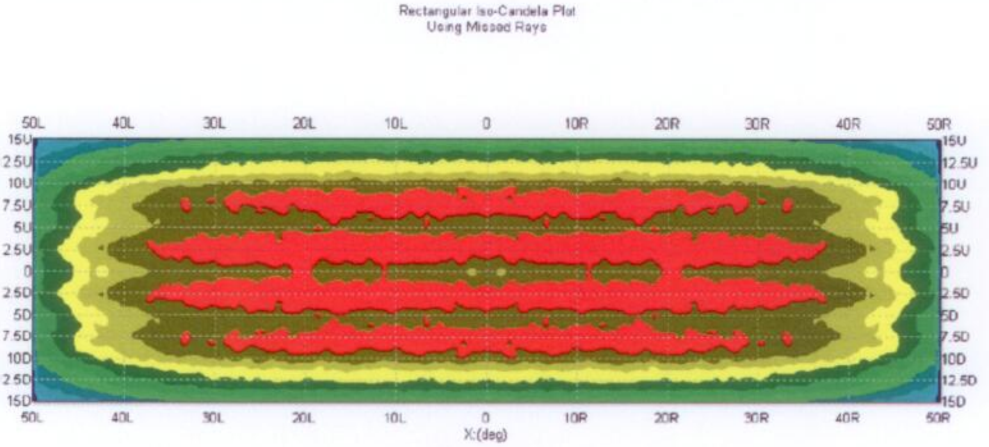

Figure 5

According to another embodiment of the disclosed technique, some of the single emitter laser diodes in the configuration irradiate light at a first wavelength, while other single emitter laser diodes in the configuration irradiate light at a second wavelength. This configuration provides a substantially uniform power irradiation front, which has different wavelengths which are dominant at different angles. For example, the configuration can include two types of single emitter laser diodes, each emitting light at a different wavelength, arranged in a checkered board like arrangement. Alternatively, the ratio between the number of the single emitter laser diodes of one type and the number of the single emitter laser diodes of the other type can be different than 1. Further alternatively, according to yet a further embodiment of the disclosed technique, more than two types of single emitter laser diodes can be used to form a configuration which provides a substantially uniform power irradiation front.

It is noted that the operating temperature of a single emitter laser diode is typically above 60 degrees Celsius, which in most cases is above the ambient temperature. Hence, using single emitter laser diodes for the disclosed technique, does not require any cooling mechanism, which often increase complexity of the overall system, its TCO (i.e., total cost of ownership) price, volume and weight. In view of the above and further according to another embodiment of the disclosed technique, a heater (not shown) is coupled to a single emitter laser diode array. This heater heats up the single emitter laser diode array to the operating temperature and provides temperature stability at that level of temperature. It is noted that this heater can be electrical (e.g., wire or TEK), hydraulic (e.g., water or oil) and the like.