J Laser Opt Photonics 2016, 3:2 (Suppl)
http://dx.doi.org/10.4172/2469-410X.C1.006

Superfocusing of the broad-aperture laser diodes and application to optical trapping and manipulation

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In this talk the recent progress of the 'interference' superfocusing of the broad-aperture multimode laser diodes will be reported. Focusing of the multimode laser diode beams is probably the most significant problem that hinders their expansion in many applications demanding both the high power and the spatial-quality of the laser radiation. Generally, the 'quality' of laser beams is characterized by the beam propagation parameter M^2 which is the ratio of the beam focal-spot size to that of the 'ideal' Gaussian counterpart focused by the same optical system. High-power broad-stripe laser diodes typically demonstrate the M^2 values of 20-50. This makes the focal-spot 1-2 orders of magnitude larger than the diffraction limit. Our idea of the 'interference' superfocusing of high-M^2 beams relies on a technique developed for the generation of Bessel beams from laser diodes using a cone-shaped lens (axicon). With traditional focusing of the multimode radiation, different curvatures of the wave-fronts of the various constituent modes lead to a shift of their focal points along the optical axis and implies larger focal-spot sizes with correspondingly increased values of M^2. In contrast, generation of a Bessel-type beam with an axicon relies on 'self-interference' of each mode and eliminates the underlying reason for increase of the focal-spot size. We utilize this technique for optical trapping of 5-6 μm red cells of rat blood in a water-heparin solution. Our results indicate the good potential of superfocused diode laser beams for applications relating to optical trapping and manipulation of microscopic objects including with aspirations towards novel lab-on-a-chip configurations.

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