GENERATION OF BESSEL BEAMS AND SUPERFOCUSING OF SEMICONDUCTOR LASER RADIATION

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Multimode high-power semiconductor lasers suffer from inefficient beam focusing with focal spot area orders of magnitude larger than that of diffraction-limited beam. This inevitably restricts their wider use in many ‘direct’ applications including biomedical photonics and material processing. This talk will review the recent progress with ‘super-focusing’ of radiation of semiconductor light sources with high beam propagation parameter M^2, where the exploitation of self-interference of modes enables dramatic reduction of the focal spot size. This can be achieved by employing a conical lens (‘axicon’) well-known for generation of non-diffracting Bessel beams [1,2]. When refracted by the conical surface, the constituting modes of the high-M^2 laser beam self-interfere and form an elongated narrow focus, usually referred to as a ‘needle’ beam. Application of an axicon for focusing of the multimode laser or light-emitting diode radiation results in dramatic reduction of the minimal focal spot size [3]. When fabricated on the tip of a multimode optical fibre, this allows to achieve the transverse size of the needle-beam in the range of 2-4 µm with a propagation length of 20 µm from a 960 nm laser with beam propagation parameter M^2=18 [4]. This gives approximately an order of magnitude reduction of the focal spot in comparison to the minimal focal spot size achievable with such a beam and an ideal lens of unity numerical aperture. The optical trapping of microscopic objects with such a super-focused multimode laser diode beam was also demonstrated [4]. This rises new opportunities within the applications sector where lab-on-chip configurations can be exploited. Most importantly, the super-focusing approach for high-power semiconductor laser radiation opens up new avenues for applications where both high power and narrow focusing is required at tight budget.

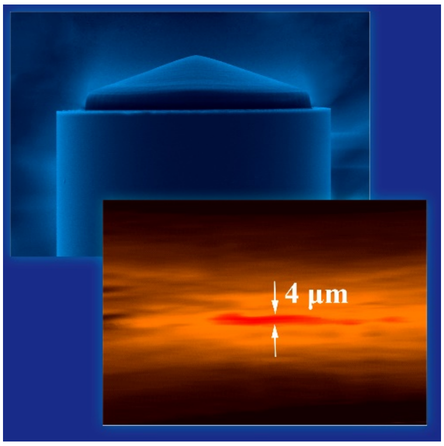

Fig. 1: Scanning electron microscope photograph of a micro-axicon on a tip of a 100 µm optical fibre and superfocusing of 960 nm semiconductor laser radiation with beam propagation parameter M^2=18.

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