Polychromatic liquid crystal laser arrays

Liquid crystal laser arrays

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1. Abstract

Band-edge lasing in a dye-doped chiral nematic liquid crystal [1-4] suffers from performance limitations at high powers. High power pump beams, focussed to extremely high intensities within the cell, can cause optical reorientation of the liquid crystal (LC), dye bleaching and other degrading effects. These effects can be significantly reduced through alteration to the method of optical pumping, which also facilitates the generation of a two-dimensional liquid crystal laser array [5].

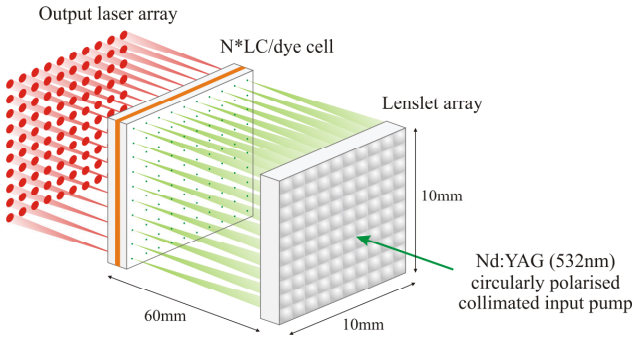

Fig. 1. A liquid crystal laser array, generated by photo-pumping with a microlens array.

The LC laser array is generated by photo-pumping the LC cell using a microlens array (fig. 1). When a collimated pulsed 532nm Nd:YAG pump beam is incident upon the lens array (fig. 2(a)), an array of focussed spots results. The dye-doped chiral nematic LC cell is positioned at the foci of these lenslets, and generates long band-edge lasing in the regions where the pump is focussed (fig. 2(b)). An array of parallel, diverging, monomode laser sources therefore results (fig. 2(c)), which display evidence of mutual coherence. If required, the output array may also be recombined into a single monomode laser emission. This can be achieved through use of a single condensing lens, or by observing the emission in the far-field, where individual LC laser sources are permitted to overlap with one-another (fig. 2(d)).

The spectra of individual microsources within the LC laser array can be shown to vary with LC sample topology. Monodomain LC samples (with a continuous chiral pitch length throughout the cell) lase at the same wavelength across the array, and can be recombined into a single monomode output (fig. 3(a)). Polydomain samples (containing slightly different chiral pitches in each domain) have been shown to generate multi-wavelength laser emission, simultaneously across the array (fig. 3(b)).

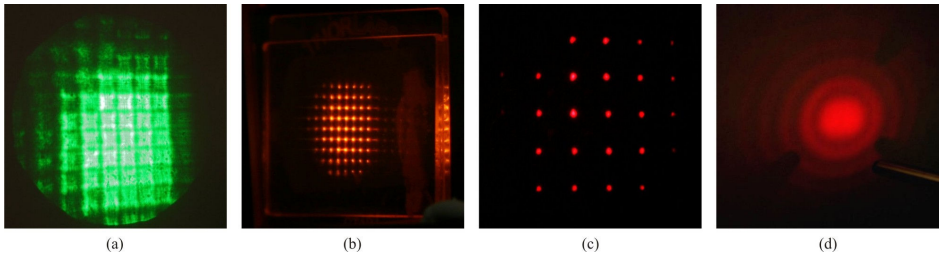

Fig. 2. Photographs of (a) the illuminated lens array, (b) the active fluorescing regions within the LC, (c) the LC laser array emission, (d) the recombined single monomode laser output.

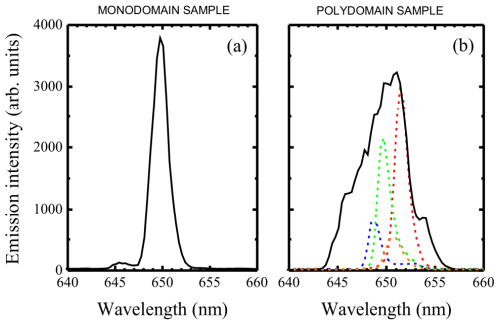

Fig.3. Recombined emission spectra (solid lines) from LC laser arrays with (a) near-monodomain LC structure with near-monomode laser output, and (b) polydomain LC structure with polychromatic laser output (broken lines represent example spectra of individual laser sources within the array).

By distributing the input pump across the LC cell in this way, we reduce the energy focussed into any individual pump spot, and thus reduce undesirable effects such as optical reorientation. Furthermore, after recombination of the output array, the overall throughput in the LC laser can be increased to values much larger than are possible with a single focussing lens, allowing the possibility of fabricating high power, micro-sized organic lasers.

2. References

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