MEMS Q-switched solid-state lasers

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This paper reports the incorporation of low-cost, scanning Micro-Electro-Mechanical Systems (MEMS) micromirrors as active Q-switch elements within a solid-state laser cavity. Active Q-switching can be achieved through the rapid scanning of an electro-static, comb-drive actuated micromirror [1]. The use of MEMS devices will allow prospects of miniaturisation of laser systems with lower fabrication costs and energy consumption than common laser Q-switch elements such as acousto-optic or electro-optic devices.

To investigate this, a three-mirror, side-pumped Nd:YAG laser cavity (fig.1) incorporating a resonant MEMS micromirror as an active Q-switch element was constructed. The total optical scanning angle of the electrostatically-actuated micromirror was measured at 75^{o} with a mechanical resonance frequency of 7.905kHz. A gold layer was deposited on the micromirror surface to ensure laser conversion efficiency and reduce thermal build-up within the silicon device. However, this coating process led to a concave surface curvature measured at ROC=0.22m. The micromirror was aligned so that the optimum cavity alignment was normal to the mirror surface. Q-switched output beams were obtained in a dual spot pattern (fig.2) with pulse durations as short as 130ns and pulse energies of up to 3.2µJ. Each individual spot was emitted consecutively with a frequency equal to the mechanical resonance frequency of the micromirror. This is due to the bidirectional nature of the MEMS movement and the time delay (measured at ~400ns) between the pulse emission and the scanning through the optimum alignment position. Moreover, an average timing pulse-to-pulse jitter of ~15ns was measured and the beam quality factor of each beam was measured at M^2 =1.1.

We will present a full characterisation of the novel active Q-switching method as well as the initial steps towards the powerscaling of this technique.

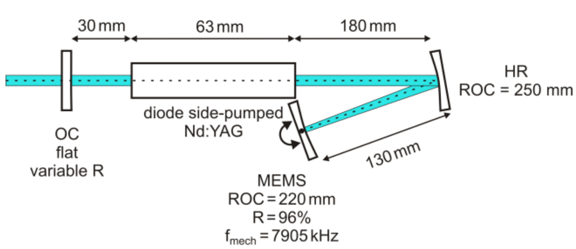

Figure 1 - Schematic of 3-mirror cavity setup

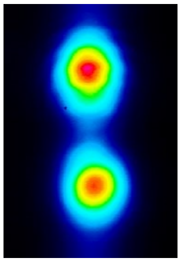

Figure 2 - Dual spot output pattern

[1] Bauer et al., Optics Letters 37, 3567-3569 (2012)