Photo-patterned liquid crystals for optical field control

Wei Hu,* Bing-yan Wei, Wei Ji, Peng Chen and Yan-qing Lu
College of Engineering and Applied Sciences, Nanjing University, Nanjing 210093, P. R. China
E-mail: huwei@nju.edu.cn,Web: light.nju.edu.cn

We present a technique for controlling the optical fields of laser beams through photo-patterned liquid crystals (LC). To write patterns into LC cells, a home-made micro-lithography system with a digital micro-mirror device (DMD) as dynamic mask forms arbitrary micro-images on photoalignment layers and further guides the LC molecule orientations. The current resolution of 3 μm is realized, while it is still improvable. Arbitrary fine photo-patterned LCs with various sizes, structures and LC alignments are thus obtained. Their EO properties are studied. Complex wavefront control of laser beams are obtained. When a voltage is applied on the cell, index re-distribution is induced due to the realignment of LC molecules, and then the optical field control become tunable. Dynamic switching between Gaussian modes and vortex beams, vector beams and airy beams are thus achieved. These advantages make the device appealing for optical tweezers, orbital angular momentum multiplexing in optical communications and even future quantum computing.

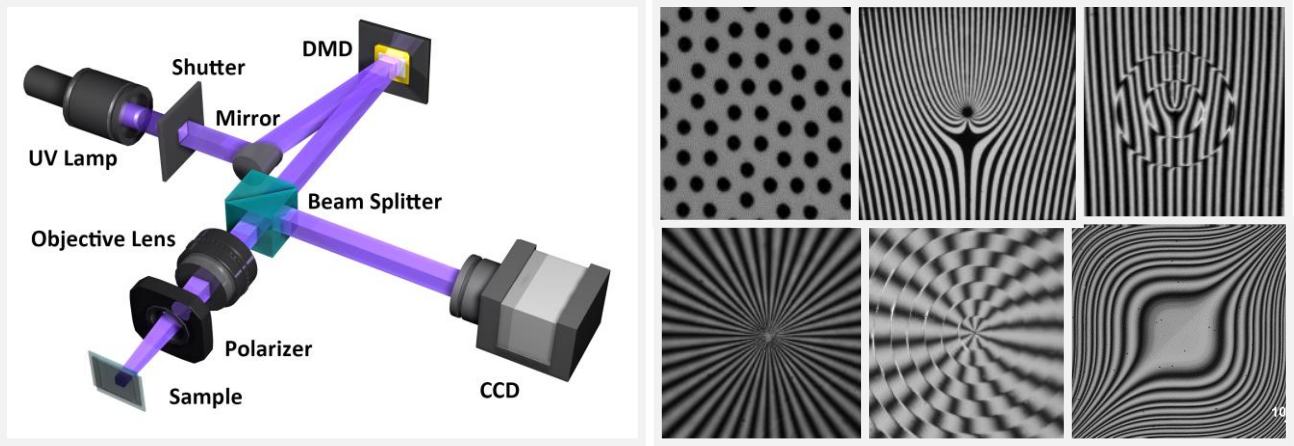

Fig. 1. (a) Scheme of the DMD based micro-lithography system. (b) The generated LC patterns.

References

1. Wu, H., Hu, W.,* Hu, H. C., Lin, X. W., Zhu, G., Choi, J. W., Chigrinov, V. and Lu, Y. Q.,* "Arbitrary photo-patterning in liquid crystal alignments using DMD based lithography system" *Opt. Express* 2012, **20**(15), 16684–16689.
2. Wei, B. Y., Hu, W.,* Ming, Y., Xu, F., Rubin, S., Wang, J. G., Chigrinov, V., Lu, Y. Q.* "Generating switchable and reconfigurable optical vortices via rewritable photopatterning of liquid crystals", *Adv*. Mater. 2014, **26**(10), 1590–1595.
3. Wang, L., Lin, X. W., Hu, W.,* Shao, G. H., Chen, P., Liang, L. J., Jin, B. B., Wu, P. H., Qian, H., Lu, Y. N., Liang, X., Zheng, Z. G. and Lu, Y. Q.* "Broadband tunable liquid crystal terahertz waveplates driven with porous graphene electrodes" *Light Sci*. *Appl*. 2015, 4, e253.
4. B. Y. Wei, P. Chen, W. Hu,* W. Ji, L. Y. Zheng, S. J. Ge, V. Chigrinov and Y. Q. Lu* "High-quality and polarization-controllable Airy beams generated via a director-variant liquid crystal mask" *Adv. Mater.* Under review.
5. Chen, P, Wei, B. Y., Ji, W., Ge, S. J., Hu, W.,* Xu, F., Chigrinov, V. and Lu Y. Q., "Arbitrary and reconfigurable optical vortex generation: a high-efficiency technique using director-varying liquid crystal fork gratings" *Photonics Research* Under review.