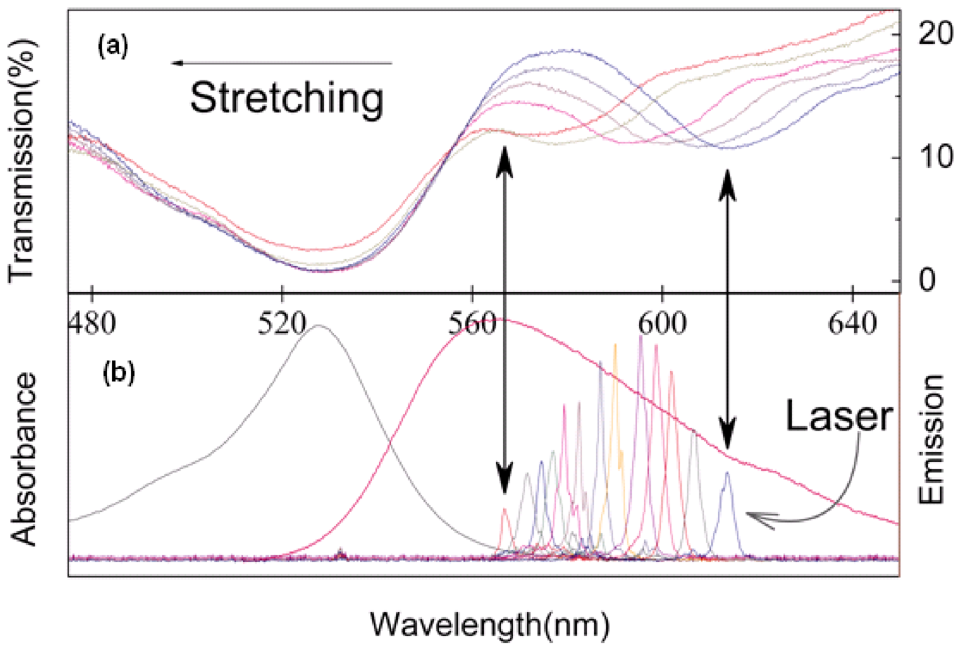

Fig. 5. Absorbance, emission, tuning transmission and tuning emission spectra of the tunable DBR elastomer laser. The series of curves in (a) (top) are the transmission curves of a single extruded film while stretching from 0% to 19%. The series of curves in (b) (bottom) are the output laser wavelength at different stretching ratios for the folded laser film. In (b), the black and the pink colored curves are the absorbance and emission spectra of the R6G laser dye doped in lotader elastomer polymer.

As shown by the transmission spectrum in Fig. 5(a), the photonic reflection band for the Bragg reflector is very broad; however, the lasing spectrum is much narrower (~2 nm in full width half maximum) as shown in Fig. 5(b). Lasing at defect states has been observed and reported previously [22] with these materials. Such phenomenon can be explained by the gain enhancement at the defect state in the photonic reflection band. The presence of defect states is important for controlling the lasing wavelength and narrowing the spectral width. Such defect states can be due to the random variations of the layer thickness of the Bragg reflector or by intentionally introducing a defect layer in the Bragg reflector. Defect states in the reflection band are thus preferred in that they not only control the lasing wavelength and spectrum width, but they also enhance the overall lasing gain resulting in lowering the lasing threshold and increasing the optical conversion efficiency.

In summary, we described a mechanically tunable all-polymer surface emitting micro-resonator dye laser with distributed Bragg reflectors. These lasers are produced entirely by a melt-process that would enable high-throughput roll-to-roll production methods. These lasers were repeatedly tunable over an approximate 50 nm range by uniaxial stretching. Lasing was observed at defect states within the reflection band. The presence of these defects led to lower observed thresholds and greater efficiency as well as more easily controlled tunability.

Acknowledgments

The authors are grateful to the National Science Foundation for financial support under the Science and Technology Center for Layered Polymeric Systems under grant number DMR 0423914. Youngstown State University acknowledges the contribution of the State of Ohio, Department of Development, State of Ohio, the Chancellor of the Board of Regents and Third Frontier Commission, which provided funding in support of the Research Cluster on Surfaces in Advanced Materials.

#141800 - $15.00 USD Received 26 Jan 2011; revised 23 Mar 2011; accepted 31 Mar 2011; published 22 Apr 2011
(C) 2011 OSA