Chapter 9

CONCLUSION AND FUTURE WORK

The research in this thesis presents fabrication and characterization of: visible sub micrometer disk lasers, visible photonic crystal slab lasers based on InGaP/InGaAlP quantum well material system; and mechanically tunable one dimensional DFB microfluidic dye lasers based on PDMS, nanoimprinted two dimensional circular grating dye lasers based PMMA. The ultra-small size of the submicron disk lasers are the smallest lasers in absolute size and the visible photonic crystal slab lasers have the smallest mode volume so far. Both are well suited for ultra-compact spectroscopic sources. The realization of two dye lasers based on the microfluidic technology enables the integration of optofluidic integrated devices.

There is still a great deal of further work to be done:

- Identify the optical mode within our ultra-small disk lasers

As described earlier, the mode observed might be the chaotic mode or higher order mode by the vertical free space pumping. We will try to use the fiber couple pumping to investigate if the whispering gallery mode would be pumped that way and to push the size limit further.

- Use the disk structure to study the surface plasmon

Our disk structure has the advantage of a thin disk membrane which could be used to enhance the surface plasmon. We will explore more how the surface plasmon would affect the laser characteristics.

- Modify the photonic crystal design for the spectroscopic source

By modifying the photonic crystal structure to have an air hole in the middle of the structure, we expect high field intensity was presented and that could be used for the spectroscopic source, as well as a high sensitivity refractive index monitor sensor. Before that, we would like to utilize the high Q toroid structure to start investigation.

- Electrically driven photonic crystal laser

The realization of the electrically pumped photonic crystal lasers are of great importance for being really functional miniaturized. We will try to explore different current injection paths and different types of PN junction. The high-frequency electrical signal would be used to test the speed of our ultra-small lasers. A polarization detector will be fabricated using the same structure.