



























## 6. Conclusions

In conclusion, we propose a novel focus grating coupler design concept using noble metals for directional light coupling at 632.8nm wavelength for silicon nitride waveguide. Our modeling and simulations show that this focusing grating structure yields free space coupling efficiency as high as 63% with minimal material loss. The noble metal grating is compatible with silicon fabrication technology through metal lift-off, electron beam lithography and dry etching process. The far-field radiation pattern as derived from 3D FDTD demonstrates the angular light coupling capability for sub-wavelength light processing circuit. Also the fluorescence vertical radiation pattern can be further utilized to enhance fluorescence signal extraction for Cy-5 fluorescent dye.

## Acknowledgments

This research was performed in the Department of Biomedical Engineering, Microelectronics Research Center (MRC), Texas Advanced Computing Center (TACC), and Center for Nano and Molecular Science (CNM) at the University of Texas at Austin. The authors would like to thank the valuable discussions with Chun-Hsien Wu on fluorescence properties of Cy-5. We thank the reviewers for their critical comments during improvement process of the manuscript. We gratefully acknowledge the financial support from, NSF CAREER Award Grants (No. 0953311) and the DARPA Young Faculty Award (N66001-10-1-4049).