Chapter 6. Conclusion

According to the description of the principle and the experiment evaluation, the self-calibrated interferometric/intensity-based (SCIIB) fiber optic temperature sensor system shows us an innovative fiber optic sensor system compared with the traditional fiber optic sensor systems. In addition to the general benefits of the traditional fiber optic sensor, the SCIIB fiber optic sensor system possesses several unique advantages. By taking advantage of the Split-Spectrum technique, the SCIIB sensor technology possesses the capability of Self-Calibration that can fully compensate for the fluctuations of optical source power and the variations of fiber losses. It combines the advantages of both the interferometric-based and the intensity-based fiber optic sensors in a single system. The sensing element — sensor head is based on the Extrinsic Fabry-Perot Interferometer (EFPI) which offers high resolution and high precision with interferometric-based sensors' advantage; the signal processing technique — detection of optical signal is based on detection of optical intensity which allows simple signal processing.

Based on the SCIIB sensor system principle, a multimode fiber-based SCIIB temperature sensor system is designed and successfully implemented. This multimode fiber-based SCIIB sensor system operates at 850nm wavelength is a good solution for short distance applications where the relatively large fiber attenuation is not a concern. With both reliable hardware and user friendly software, the SCIIB temperature sensor system consists of three parts – Sensor Head, SCIIB Instrument Box and Data Acquisition Board (DAB) & computer.

In order to achieve all the potential advantages of the SCIIB technology, an innovative method named thermal fusion technique using a carbon dioxide (CO_2) laser for bonding is developed by the Photonics Lab at Virginia Tech to fabricate high-performance sensor heads based on theoretical investigation and experimental probation. Furthermore, a set of accompanying quasi-automatic fabrication system for making sensor heads is set up, which makes the fabrication of sensor heads easier and more accurate to control the initial condition of the sensor heads. The sensor fabrication system uses a CO_2 laser as the heating source to locally fuse the capillary tube and fiber together. The whitelight interferometry subsystem provides the system with the capability of on-line monitoring of the sensor F-P cavity length in real-time. The computer controlled stage system allows the accurate adjustment of the sensor cavity length during the sensor fabrication. The integration of these three parts permits the sensor to be fabricated in a controlled fashion and reinforce the sensor's capability.

Comprehensive experiments are performed to evaluate the principle of SCIIB technology and the performance of the multimode SCIIB temperature sensor systems. The experiment results illustrate that the development of the SCIIB fiber optic temperature sensor system provides a reliable tool for the temperature measurement capable of operating in high temperature harsh environment. A high-performance sensor system with operating range of 800 °C is illustrated in the thesis.

Based on the principle analysis and the experimental evaluations, we can see the SCIIB sensor technology is expected to provide several unique advantages: 1) High Resolution and Precision, 2) Large Dynamic Range, 3) Self-Calibrated Ability, 4) Simple Signal Processing Technique, 5) Absolute measurement, 6) Design and Fabrication Flexibility, 7) Suitability for Harsh Environment.