Optical fiber sensors

Shin-chun Lin

(Navel Research Laboratory)
Washington, D. C. 20375, Tel: (202) 767–3068

The materials of the modern optical fibers have been found to exhibit photoelastic, electo-optic and magneto-optic properties when subjected to external disturbances caused by mechanical stresses, temperature variations, electromagnetic fields. As a consequence, the propagation constants of the optical modes in fibers are changed. While these changes may not be desirable for optical communications, they can be exploited for the measurements of the external disturbances. With the development of very low-loss fibers ($\alpha <$ 0.5 dB/km), the sensitivity of measurement can be greatly enhanced by using long lengths of fibers. In fact, many ideas of using optical fibers as sensors have appeared in the literature. For example, optical fiber interferometers for acoustic pressure sensoring have been demonstrated to surpass the best piezo-electric hydrophone. Optical fiber ring interferometers can also outperform the ring lasers as gyros in the quantum-noise-limited sense. In this paper, I will review first the external effects on optical fibers; then ,the changes of the phases of the optical modes, and the sensitivities of various detection schemes. Finally, unique advantages of optical fiber sensors and novel applications in instrumentation will be given.

光纤传感器

Shin-chun Lin

(海军研究所)

已发现近代光纤材料在受到机械应力、温度变化和电磁场的外界干扰时显示出光弹、电光和磁光特性。其结果使光纤中光模的传输常数发生变化。虽然这些变化对光通信来讲可能是并不希望有的，但它却能被开拓用于对外界干扰的测量。随着极低损耗光纤($\alpha <$ 0.5分贝/公里)的发展，可以使用长光纤使测试灵敏度大大提高。事实上，把光纤用作传感器的许多设想已在文献上出现。例如，用于声压传感器的光纤干涉仪比最好的压电水声器更为优越。光纤环形干涉仪在量子噪声极限检测方面同样能比用作陀螺的环形激光器工作得出色。在本文中，我首先评述外界效应对光纤的作用；然后评述光模的位相变化和不同检测方案的灵敏度。最后给出了光纤传感器独一无二的优点和在仪器中的新应用。