

# OPTICAL FIBER SENSOR TECHNOLOGY

# **Optical Fiber Sensor Technology**

## **Fundamentals**

Edited by

**K. T. V. Grattan**

and

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# Preface

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## **Fundamentals of Optical Fiber Sensor Technology**

The field of optical fiber sensors continues to expand and develop, being increasingly influenced by new applications of the technologies that have been the topics of research for some years. In this way, the subject continues to mature and reach into new areas of engineering. This text in the series on *Optical Fiber Sensor Technology* provides a foundation for a better understanding of those developments in the basic science and its applications in fiber sensors, underpinning the subject today. This book builds upon the work in an earlier single volume which covered a broad area of the subject, but which now, in this, volume 1 of the series, focuses upon the fundamentals and essentials of the technology. Material which is included has been carefully reviewed and in most cases thoroughly revised and expanded to reflect the current state of the subject, and provide an essential background for the more applications-oriented content of the subsequent volumes of the series.

This volume opens with a status paper on optical fiber sensor technology, by Kenneth Grattan and Tong Sun providing in it a flavor of the main topics in the field and giving an essential overview at the sort of systems which are discussed in more detail in the other chapters in the whole series. An extensive publication list of readily accessible papers reflecting these topics is included. This is followed by a chapter on the fundamental physics of optical fibers and their fabrication from Vince Handerek, covering the essentials of how different fibers are produced and work, and details of the variety of fibers available to the sensor user. The aim has not been to duplicate the contents of a typical undergraduate optics text book but to grasp those aspects that are essential to a working knowledge of optical fibers, as a basis for the further chapters. A major (but not exclusive) theme of subsequent work is single mode optical fibers and their uses in sensing.

Consequently, the next chapter of the volume is a review of the fundamentals and principles of single mode optical fiber sensors, with a number of illustrative examples, again carefully written by Vince Handerek.

The chapter illustrates some of the essential principles of both basic and more sophisticated optical fiber sensor systems, and it is followed by a review by Ralph Tatam of the modulation techniques which have been applied to such single mode sensors and their design for a number of applications.

The field of interferometry has been very influential in optical fiber sensor technology, since its inception with the conversion of conventional and familiar open air-path interferometers to fiber optic use. Y-J Rao and David Jackson provide an excellent review of developments in fiber optic interferometry coupling the underpinning science and the basics of optical fibers with discussion of potential applications and uses. This is complemented by a chapter by Beverley Meggitt on one important aspect of interferometry that shown a very significant level of development – low coherence or (historically) 'white light' interferometry, reviewing the working principles of these devices and discussing a number of topical applications.

The wide variety of sources, both coherent and incoherent, laser, LED and lamp-based that are used or may have potential future applications in optical fiber sensors is discussed by Kenneth Grattan in a chapter of this volume. The field has opened up recently with blue and blue/green solid state lasers, a wider variety of more versatile fiber lasers often incorporating Bragg gratings, new organic polymer sources and bright LED systems over a more extensive wavelength range, and discussion of these, of their working principles is included. This is supported by a further chapter by Kenny Weir and Julian Jones on detectors for optical fiber sensors, dealing with major issues including performance, noise and the variety of detectors available for use with the range of sources concerned in the previous chapter. Together they provide a comprehensive discussion of this important aspect of any fiber optic sensor system.

As with all the volumes of this series, this work draws its authority from the reputation of the authors as the writers of many of the major papers in the field, published in the leading journals internationally and having been presented by them at the major Conference series around the world. The authors of these papers on the fundamentals of the subject are the users of the technology – developers of optical fiber sensors for a number of industrial applications and for whom these fundamentals of the subject are the essential material that underpins their research. Their work is carefully referenced to both seminal and topical papers in these major international journals, to relevant websites and both to text books and to other chapters in the subsequent volumes in this series.

The editors are very grateful to Dr Tong Sun for her tireless efforts in typesetting this manuscript from the authors' original material and in preparing the diagrams from a wide range of sources for publication.

The editors hope that this volume on the fundamentals of the subject of *Optical Fiber Sensor Technology* will provide the encouragement to delve more deeply into the subject and thus into the subsequent volumes of this series which cover a very wide range of topical devices, applications and systems.