

Guidance for residual stress measurement of optical fibre

ICS 33.180.10

National foreword

This Published Document is the UK implementation of IEC/TR 62469:2007.
The UK participation in its preparation was entrusted by Technical Committee GEL/86, Fibre optics, to Subcommittee GEL/86/1, Optical fibres and cables.
A list of organizations represented on this committee can be obtained on request to its secretary.
This publication does not purport to include all the necessary provisions of a contract. Users are responsible for its correct application.

This Published Document was published under the authority of the Standards Policy and Strategy Committee on 30 November 2007

© BSI 2007

ISBN 978 0 580 57356 9

Amendments issued since publication

Amd. No.	Date	Comments



TECHNICAL REPORT

Guidance for residual stress measurement of optical fibre

CONTENTS

1	Scope	3
2	Justification of measurement	3
3	Apparatus	4
3.1	General	4
3.2	Light source	4
3.3	Polarizer and analyzer	4
3.4	Sample fibre preparation	4
3.5	Variable phase compensator	4
3.6	Optical intensity detection	5
3.7	Data acquisition	5
4	Data analysis and formula	5
4.1	General	5
4.2	1-D stress profile for a fibre with a cylindrically symmetric structure	6
4.3	2-D stress profile for a fibre with a cylindrically non-symmetric structure	7
5	Measurement procedure	10
5.1	Alignment of polarizer and analyzer	10
5.2	Fibre mounting	10
5.3	Taking transmitted intensity data $I(y, \theta)$	10
5.4	Calculation of 1-D stress profile for a fibre with a cylindrically symmetric structure	10
5.5	Calculation of 2-D stress profile for a fibre with a cylindrically non-symmetric structure	10
6	Documentation	10
6.1	Information to be reported for each measurement	10
6.2	Information that should be available upon request	11
	Bibliography	12
	Figure 1 – Polariscopic phase retardation measurement setup for an optical fibre	4
	Figure 2 – Measured transmission intensity as a function of fibre radius and external phase	5
	Figure 3 – Propagation of laser light across the fibre cross-section	6
	Figure 4 – Stress profile for a fibre with depressed inner cladding and jacketed tube	7
	Figure 5 – Examples of projected phase retardation measurement $\delta(y)$ for a PM fibre as a function of fibre radius y when the projected angle α is 0° , 45° , 90° , and 135°	8
	Figure 6 – Measured projected phases $\delta(y, \alpha)$ of a PM fibre for various projected angles as a function of fibre radius	9
	Figure 7 – Calculated 2-D stress profile of a PM fibre	9

GUIDANCE FOR RESIDUAL STRESS MEASUREMENT OF OPTICAL FIBRE

1 Scope

The measurement of residual stress distribution in an uncoated glass optical fibre is considered to be important as it affects critical fibre parameters such as refractive index, intrinsic polarization mode dispersion, mode field diameter and dispersion. The optical polarimetric method is a well-established technique to measure the residual stress of an optical material. This technical report describes a transverse polarimetric method to measure the residual stress profile of any type of optical fibre.

The principle and detailed procedure for measuring the optical transverse stress profile of a fibre, which is cylindrically symmetric, is described in detail. It is based on a polariscope, which is constructed with a fixed polarizer, a quarter-wave plate and an analyzer. An optical tomographic technique is also described for measuring the stress profile of a fibre with a cylindrically non-symmetric structure.

2 Justification of measurement

Residual stress in an optical fibre is induced by the combination of the fibre construction and the drawing process. The stress information is important because it affects many important parameters of an optical fibre due to the following reasons.

- Temperature dependent changes of fibre parameters are larger for a fibre with larger residual stress, and these are responsible for the statistical behaviour of polarization mode dispersion (PMD) changes in deployed fibre links. (See references [10-12].)¹⁾
- The variation of important fibre parameters such as chromatic dispersion, mode field diameter, PMD depends on the intrinsic residual stress of an optical fibre. (See references [13-17].)
- The asymmetric residual stress profile of a fibre causes fibre curl, which affects cleaving quality for an optical fibre ribbon.
- The asymmetric residual stress of a fibre is a major cause of the intrinsic PMD of an optical fibre. (See references [18-20].)
- Excessive residual stress can lead to core cracking that might be seen in, for example, the preparation of the ends for connectors.
- The design of polarization retaining fibres normally involves inducing a non-symmetric stress field. This measurement can be used to confirm these designs.

Much progress has been made in measuring the residual stress profile of an optical fibre (see references [1-9]) such that spatial resolution can be as small as 0,6 μ and accuracy in measuring stress can be as low as 0,4 MPa.

Depending on the application, either one- or two-dimensional stress data may be needed. This document describes methods by measuring the polarization rotation of a transversely exposed laser light across a fibre cross-section using a polarimetric method.

¹⁾ Figures in square brackets refer to the Bibliography.