BIO-RAD

M41

MICROMEASUREMENT

SYSTEMS

FIBERCHECK M41 SYSTEM

MICROMEASUREMENT FOR THE FIBRE OPTIC INDUSTRY

IMAGE SHEARING: Tried and tested and still the best and most precise method for the routine measurement of fibre geometries.

PRECISE MEASUREMENT OF FIBRE GEOMETRIES

Fibercheck has been designed to ensure that even inexperienced operators can use Bio-Rad's unique Image Shearing methodology to achieve the extremely accurate and repeatable fibre geometry measurements demanded by today's optical fibre manufacturers and users. The system, developed in close co-operation with the fibre industry, includes computer control of image rotation, easy to follow screen prompts and full data analysis, presentation and statistics. The system may also be used in a fully manual mode.

Fibre type	Geometry	Typical Achievable Precision
Single-mode	Cladding diameter	better than 0.1 microns
" "	Cladding ovality	better than 0.1%
" "	Core diameter	better than 0.05 microns
" "	Core ovality	better than 0.5%
" "	Core/cladding concentricity	better than 0.05 microns
Multi-mode	Cladding diameter	better than 0.1 microns
" "	Cladding ovality	better than 0.1%
" "	Core diameter	better than 0.1 microns
" "	Core ovality	better than 0.5%
" "	Core/cladding concentricity	better than 0.05 microns

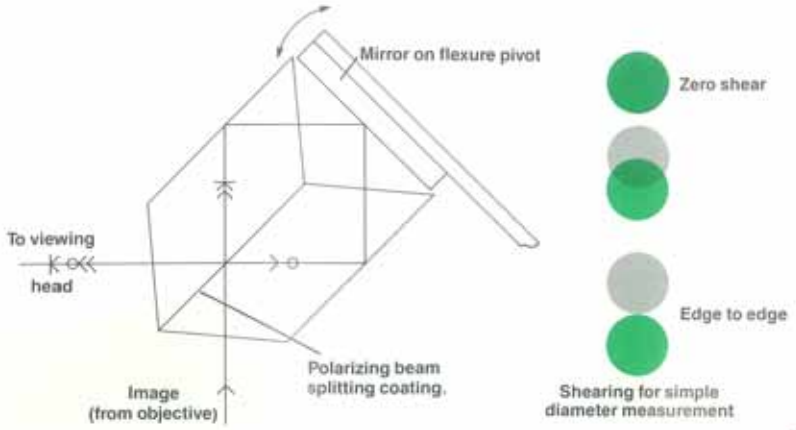
IMAGE SHEARING

M41 Micromeasurement Systems all incorporate Bio-Rad's unique image shearing methodology, enabling the most accurate and repeatable measurements to be made. The image shearing module, positioned between the system objective changer and the viewing head, produces two identical images of the feature to be measured. Fibre geometries are measured by moving these images relative to each other, until the required geometry edges just touch. The amount of shear or image movement, calibrated for fibre measurement, is simultaneously displayed on a digital read-out unit and downloaded to the computer for data analysis, screen presentation and print-out if required. Image rotation, under computer control (with manual override) is also facilitated within the image shearing module.

HOW IT WORKS

Light from the image enters a prism arrangement impinging on a polarizing beam splitter interface where it is orthogonally polarized. One beam is transmitted through the interface, the other totally reflected. Each beam follows a common, closed loop path, in opposite directions, via an external mirror and making either two transmissions or two reflections of the beam splitting interface.

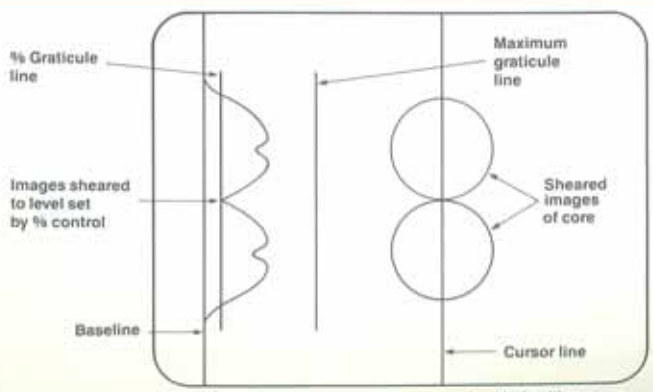
The light emerging from the prism arrangement consists of two image beams which, when the mirror is perfectly normal to the beam splitter, will be completely superimposed. Image shearing is achieved by tilting the mirror which is mounted on a flexure. Flexure movement is very precisely monitored by a strain gauge bridge configuration. Thus the output of the bridge is a direct measure of the amount of image shear.



Once calibrated against standards provided with the systems, fibre geometries can be measured with extreme accuracy and repeatability. Because of the nature of the image shearing method measurements are much less susceptible to focus variation and vibration effects than other systems.

Unlike other systems, image shearing measurements are independent of video camera non-linearity.

INTENSITY PROFILE DISPLAY

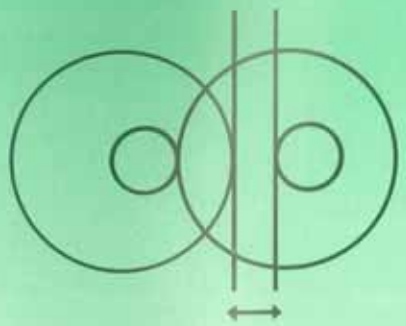


Core diameter measurement on graded index fibres

By displaying on the monitor a profile of the light intensity of the images as they are sheared, the sheared image edge "just touch" or a pre-set (variable) profile percentage level can be observed in the profile enabling even more accurate and precise measurement.

A user settable cursor line is displayed on the monitor which defines the image position to which the profile relates. The profile itself consists of light reflected from the cladding (cladding measurement), light transmitted from the special launch system through the fibre (core measurement) and light from both sources (concentricity measurement).

AUTOMATED CONCENTRICITY MEASUREMENT



concentricity error (x2)

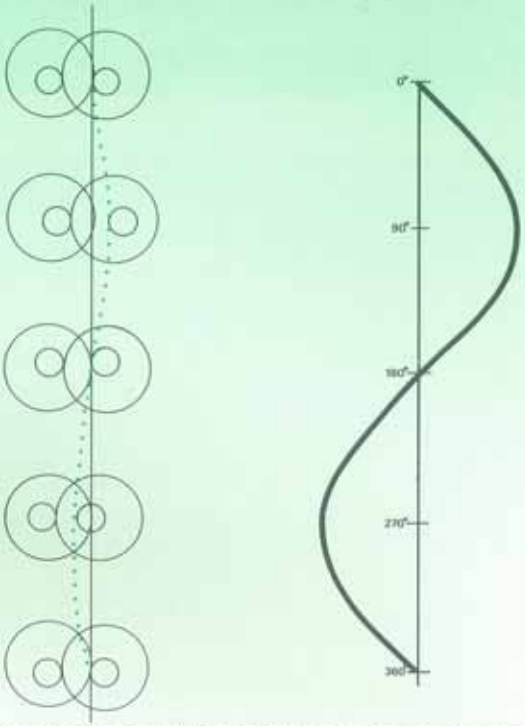
Fibercheck incorporates concentricity measurement theory developed by British Telecom Research Laboratories. The core edge of one image is brought to 'just touch' the cladding edge of the other image so that the concentricity error in the direction of shear is one half of the displacement between the alternate core and cladding edges.

By rotating the images and measuring the displacements at discrete angular positioning, the resulting readings should follow a sine curve – the amplitude of which, when calibrated, is the true concentricity error.

Fibercheck allows preselection of the number of angular positions and automatically rotates the images. Concentricity readings are logged, together with angular displacement data, for analysis and presentation of complete concentricity information including the sine curve.

Provided the fibre under test has passed ovality/non-circularity tests (on Fibercheck) any deviation in experimental readings from a sine curve will be mostly attributable to variation in operator performance. Fibercheck's program computes a 'confidence index' which monitors individual operator variation and hence aids quality control decisions.

Fibercheck allows accurate concentricity measurements to be made even in the presence of some end cleave hackle and damage.

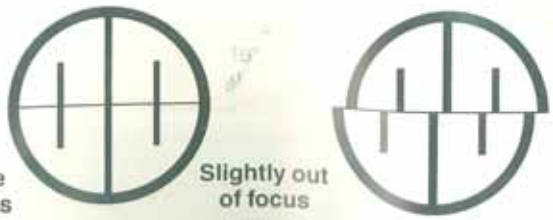


Calibrated sine curve amplitude is concentricity error

PRECISE FOCUS

M41 Measurement Systems all include Bio-Rad's unique Precise Focus Indicator. An index grid may be switched in to appear through the eyepieces or on the monitor as a circle with a centre line and two short vertical lines to either side. If the image is slightly out of focus the grid appears divided across the centre. At true focus the lines are straight and continuous across the circle.

Precision of focus setting, even to the untrained operator, is of the order of one tenth of the depth of focus for the objective employed. For an objective of Numerical Aperture of 0.85 (e.g. the 80X Microplan supplied with the system) precision of setting, in green light, is 0.07 microns.



True focus

Slightly out of focus

END CLEAVE ANGLE

Provided a fibre is held vertical in Fibercheck patented fibre holder, the precise focus indicator may be used to obtain a measure of end cleave angle. By accurately focusing on one side of the fibre end, zeroing the Z-axis read-out provided with Fibercheck, then re-focusing on the other side of the fibre end, the amount of movement in the Z-direction can be read. From fibre diameter and this Z movement the end cleave angle is easily calculated.

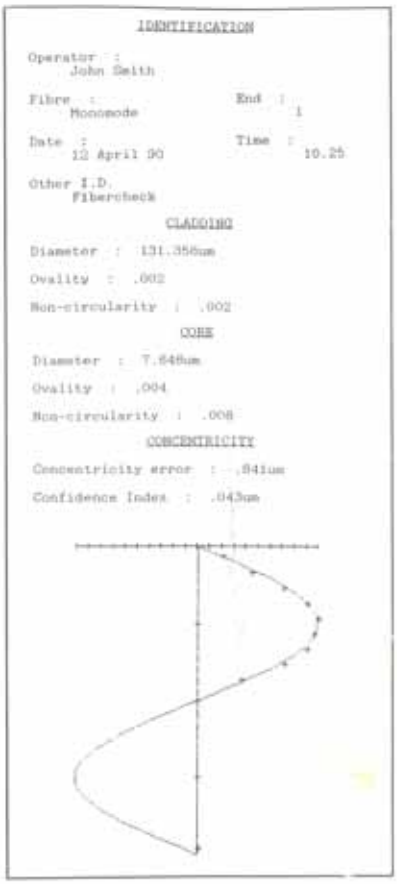
FIBERCHECK SYSTEM

- Rugged stand with CCTV facilities
- Full range of bright/dark field objectives
- Image shearing optics module and read-out
- Intensity profile display and control unit
- Precise focus indicator
- Patented fibre holding stage facilities
- Fibre launch system for illuminating cores
- Z-axis measurement and read-out
- Calibration standards
- Software for selected computer

Software available for HP85A, HP85B, IBM P.C. and HP300 series. Please request details.

FIBERCHECK MEASURES all cladding and core geometries including core/cladding concentricity.

STATISTICS includes mean and standard deviation (screen and print-out). Filtering by operator, batch etc. for QC analysis.



Typical Measurement Print-out

MANUAL FIBERCHECK

Fibercheck is also available as a purely manually operated system without computer control and data handling; but fully equipped with image shearing and readout, CCTV, intensity profile display and precise focus. Manual Fibercheck is available with or without the Z-axis measurement facility and offers an inexpensive option for fibre Geometry measurement in the more cost conscious laboratory.

PRIME ACCESSORY FOR FIBERCHECK

CONNECTOR MEASUREMENT MODULE

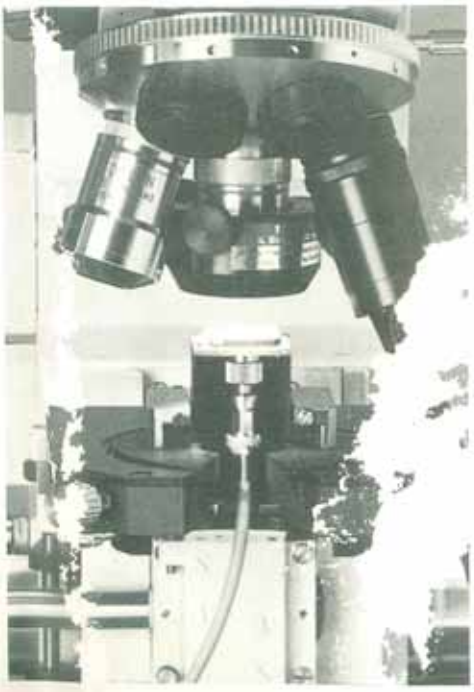
Direct, precise measurement of connector concentricity error, internal and external diameters of connectors and ferrules extends the Fibercheck capability.

Custom designed Fibercheck connector holders made to order to ensure satisfactory measurements can be made.

- Ring illuminator and 150 watt power source
- Full range of required objectives in Quintuple changer
- Standard ferrule holders (5mm and 3mm)
- Custom designed connector holders on request
- Calibration standard

Values of Mean of Measurements and Standard Deviations from experimental data

Connector/Ferrule	External Diameter (um)	Hole/Internal Diameter (um)	Precision of Hole to External Diameter Concentricity Error (um)
Ferrule (Ruby)	1583.9±0.2	132.4±0.1	±0.1
Connector (3 Ball) Stainless Steel	1812.8±0.2	646.2±0.2	±0.2
Connector (Stainless Steel)	2489.0±0.9	123.8±0.1	±0.2
Connector (Plastic)	2606.9±1.0	1156.5±0.9	±0.8



BIO-RAD

NANOQUEST LIMITED
Connercial Optics
Haxby Road, York
YO3 7SD, England
Telephone: (0904) 631351
Fax: (0904) 645624
Telex: 57660

NANOQUEST INC.
800 West Cummings Park
Suite 1900
Woburn, MA 01801
U.S.A.
Telephone: 617 932 3800
Fax: 617 932 3283
Telex: 94-9413

NANOQUEST IN
2968 Scott Boulevard
Santa Clara
CA 95054, U.S.A.
Telephone: 408 988 0659
Fax: 408 988 7927
Telex: 497-4744

NANOQUEST (CANADA) INC.
2930 Ba[illegible] Road
Nepean, Ontario K2H 8T5
Canada
Telephone: 613 820 9437
Fax: 613 820 2924
Telex: 053-3189