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Contents

vii	Conference Committee
ix	Preface

WAVEGUIDE DESIGN AND FABRICATION

3	Ion-exchange process for glass waveguide fabrication G. C. Righini, IROE-CNR (Italy)
25	Critical issues in designing glass integrated optical circuits A. Tervonen, Optonex Ltd. and Nokia Research Center (Finland)

DEVICE FABRICATION

55	Glass integrated optical devices on silicon for optical communications [CR53-03] M. F. Grant, BNR Europe Ltd. (UK)
----	--

SOL-GEL AND RARE-EARTH-DOPED FIBERS AND WAVEGUIDES

83	Sol-gel process for glass integrated optics J. D. Mackenzie, Y.-H. Kao, Univ. of California/Los Angeles
114	Fibers from gels and their applications S. Sakka, Kyoto Univ. (Japan)
132	Integrated optical devices in rare-earth-doped glass K. J. Malone, National Institute of Standards and Technology

COMMERCIAL DEVICES

159	Ion-exchanged glass waveguide devices for optical communications S. Honkanen, Nokia Research Center and Helsinki Univ. of Technology (Finland)
180	Ion-exchanged glass waveguide sensors L. Ross, IOT GmbH (FRG)
200	Commercial glass waveguide devices M. D. McCourt, Corning Opto-Electronic Components (France)

NONLINEAR FIBERS AND WAVEGUIDES I

- 211 **Quantum dot glass integrated optical devices**
N. Peygambarian, H. Tajalli, E. M. Wright, S. W. Koch, Optical Sciences Ctr./Univ. of Arizona; S. I. Najafi, École Polytechnique de Montréal (Canada); D. Hulin, ENSTA (France); J. MacKenzie, Univ. of California
- 235 **Photosensitive glass integrated optical devices**
B. J. Ainslie, G. D. Maxwell, D. L. Williams, BT Labs. (UK)

NONLINEAR FIBERS AND WAVEGUIDES II

- 253 **Fused bitapered fiber devices for telecommunication and sensing systems**
S. Lacroix, École Polytechnique de Montréal (Canada)

DEVICES FOR COMMUNICATION AND SENSORS I

- 281 **Glass waveguides with grating**
M. Fallahi, National Research Council of Canada and Solid State Optoelectronic Consortium (Canada)
- 295 **Multimode glass integrated optics**
O. M. Parriaux, P. Roth, G. Voirin, CSEM (Switzerland)
- 321 **Glass waveguides in avionics**
F. A. Blaha, Canadian Marconi Co. (Canada)

DEVICES FOR COMMUNICATION AND SENSORS II

- 335 **Fiber-to-waveguide connection**
J.-F. Bourhis, Alcatel Cable Interface (France)
- 367 **Optical fiber chemical sensors**
M. Shadaram, Univ. of Texas/El Paso

Conference Committee

Conference Chair

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- 1 Waveguide Design and Fabrication
S. Iraj Najafi, École Polytechnique de Montréal (Canada)
- 2 Device Fabrication
Giancarlo C. Righini, IROE-CNR (Italy)
- 3 Sol-Gel and Rare-Earth-Doped Fibers and Waveguides
Nasser Peygambarian, Optical Sciences Center/University of Arizona
- 4 Commercial Devices
Ari Tervonen, Optonex Ltd. (Finland)
- 5 Nonlinear Fibers and Waveguides I
David N. Payne, University of Southampton (UK)
- 6 Nonlinear Fibers and Waveguides II
B. J. Ainslie, BT Laboratories (UK)
- 7 Devices for Communication and Sensors I
Seppo Honkanen, Optonex Ltd. (Finland)
- 8 Devices for Communication and Sensors II
Mahmoud Fallahi, National Research Council of Canada

Preface

Two distinctly different types of guiding structures are used to make glass waveguide devices: optical fibers and integrated optical waveguides.

There has been remarkable progress in optical fiber devices. Optical fibers have been used to study and demonstrate a number of important phenomena such as optical amplification, soliton propagation, and pulse break-up. All-fiber devices have been produced using readily available optical fibers.

Glass integrated optics was rather slow starting, but outstanding progress has been achieved during the past decade or so. High performance integrated optical devices and circuits have been fabricated.¹⁻³

Different techniques are used to make glass integrated optical devices. Ion-exchange is the most popular. This technique is simple and can be used to make reproducible and low-cost devices. Recently, a flame hydrolysis technique has attracted attention, probably because the resultant waveguides can be fused to optical fiber, which improves environmental stability of the chip and eliminates back reflection in the fiber-chip interface. Plasma deposition offers the possibility of doping waveguides to achieve nonlinear devices. The sol-gel method is flexible and can be used to make waveguides with different dopants (e.g., rare earths, semiconductors, photosensitive elements). It is also attractive for fabrication of hybrid circuits. Figure 1 depicts a hybrid $1.3\ \mu\text{m}/1.55\ \mu\text{m}$ amplifier/splitter.² Ion implantation also has been employed to make glass waveguides. In addition, we have used Ge implantation to make waveguides. A simple photoresist mask has been used to produce channel waveguides. However, the waveguides had rather high propagation losses. In addition, the fabrication process is very costly and is not suitable for device fabrication.

Accurate theoretical tools have been developed to design glass integrated optical devices.⁴⁻⁶ New and complex devices have been proposed, analyzed, and demonstrated. In particular, waveguides with grating have attracted a lot of attention.^{7,8} Figures 2 and 3 depict two examples of such devices. In Figure 2 we propose a new rare-earth-doped glass waveguide laser. The grating with variable width is used to diffract a symmetric laser beam perpendicular to the waveguide surface. In Figure 3 we suggest a narrow band wavelength division multi/demultiplexer.⁹

This critical review includes papers, authored by recognized experts, discussing optical fibers and the progress and future potential of glass integrated optical devices.

(continued)

Fig. 1. 1.3 μm /1.55 μm glass integrated optical amplifier/splitter circuit.² The composite waveguides can be achieved using rare-earth-doped sol-gel glasses.

Fig. 2. Rare-earth-doped glass integrated optical symmetric beam surface emitting laser.

Fig. 3. Integrated optical narrow-band wavelength division multi/demultiplexer.⁹

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