

SPECIAL ISSUE "FIBRE LASERS" DOI: 10.1070/QEL16270

Fibre lasers

E.M. Dianov

The advent of fibre lasers is one of the most brilliant achievements of quantum electronics.

The first fibre laser was demonstrated by Snitzer in 1963 [1]. The gain element in that laser was a glass fibre containing neodymium ions. However, this area of laser physics did not gain momentum at the time, and it is clear why. The advent of modern, highly efficient and compact FLs became possible owing to the development of glass fibres with low optical losses (~1 dB km^{-1} in the near-IR region) in the early 1970s and subsequent explosive growth of optical fibre communication systems. The latter circumstance became a key factor in the development and commercial-scale production of durable, bright laser diodes; a variety of specialty optical fibres, including those doped with rare-earth elements; and refractive-index Bragg gratings. These components were basic to the advent of the FL.

An important result was the development of bismuth-doped fibres as a new active medium, which enabled bismuth-doped FLs to emerge [2].

Optical fibres as a lasing medium have important advantages over bulk active media: low optical loss, long interaction length, small core diameter, large fibre surface area to volume ratio, the possibility of using in-fibre refractive index Bragg gratings as distributed reflectors and high output beam quality. All this ensures high laser diode pump efficiency, facilitates heat dissipation and ensures a compact design and high stability of FLs. As a result, a wide variety of fibre lasers have emerged, including high-power cw lasers, pico- and femtosecond lasers, single-frequency lasers and Raman lasers.

This issue of *Quantum Electronics* publishes the most interesting reports presented at the 7th Russian Seminar on Fibre Lasers (5–9 September 2016, Novosibirsk).

The above-mentioned advantages of FLs ensured them wide use and led to the necessity of improving their characteristics, which was reflected in the scientific program of the seminar.

Until recently, only rare-earth-doped silica fibres served as active optical fibres. Rare-earth-doped FLs are incapable of efficiently operating in the spectral ranges 1150–1500 and 1620–1750 nm. Recently demonstrated bismuth-doped FLs emit in the spectral ranges 1150–1530 and 1650–1775 nm [3, 4]. Owing to this, the rare-earth- and bismuth-doped FLs cover essentially the entire spectral range 1000–2200 nm, which was reflected in the results presented at the seminar. This issue publishes two papers concerned with bismuth-doped FLs: a picosecond laser emitting at a wavelength of 1.3 μm and a cw laser tunable over the range 1360–1510 nm.

One problem with the FLs is the necessity of increasing the concentration of active elements. Two approaches are currently used to resolve this problem: the selection of the core glass composition [5] and the use of porous glass for raising the concentration of active centres without clustering, followed by the fabrication of active optical fibres [6]. This issue presents a report describing fibres with high rare-earth ion concentrations in their phosphate glass core and characteristics of related FLs.

At present, ultrashort-pulse FLs are widely used in a variety of technological, medical and scientific applications. Several interesting papers in this issue address the fabrication and investigation of pulsed ytterbium, bismuth, erbium and holmium fibre lasers.

The paper concerned with high-power cw visible lasers is of great practical interest. Efficient (~25%) SHG in periodically poled lithium tantalate crystals pumped by a narrow-band Raman fibre laser has been demonstrated for the first time.

Interesting results are also presented in two papers that describe Raman fibre lasers, in particular, efficient generation of linearly polarised light in a random distributed feedback Raman laser, and in the paper 'Stabilization of a fibre frequency synthesiser using acousto-optic and electro-optic modulators'.

This issue contains reports that are not directly related to fibre lasers but pertain to their applications. Three of them examine the influence of nonlinear effects on the transmission capacity of optical fibre communication systems and are of obvious interest for experts in this area of research. One paper reports the fabrication and investigation of a hollow-core microstructured fibre for the UV region, with an optical loss of 3 dB m^{-1} at a wavelength of 250 nm. There is also a paper describing the fabrication and characterisation of a switchable delay line based on a 1300-m-long seven-core fibre. Such a delay line is potentially attractive for the manufacture of microwave photonics devices.

E.M. Dianov Fiber Optics Research Center, Russian Academy of Sciences, ul. Vavilova 38, 119333 Moscow, Russia;
e-mail: dianov@fo.gpi.ru

Kvantovaya Elektronika **46** (12) 1067 (2016)
Translated by O.M. Tsarev

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