THE SOUTHAMPTON UNIVERSITY/UCL OPTOELECTRONICS RESEARCH CENTRE

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The Optoelectronics Research Centre (ORC) is an SERC-sponsored Interdisciplinary Research Centre based largely at Southampton University, with further laboratories at UCL. Associated universities are Sussex, Oxford, Kent and King's College London. During the first two years of its existence, the ORC has expanded to a complement of over 100 people housed in custom-built optical laboratories and a major clean-room complex. The worldwide reputation of the Centre is such that an increasing number of contracts are being secured from industry, the EC and Government.

Optical fibres have revolutionised telecommunications and planar waveguides are set to provide the complex and functional optical "printed circuits" of the future. Consequently, the fabrication of planar and fibre waveguides remains a central part of the ORC research with particular emphasis on optical materials, especially novel glasses. In the case of rare-earth-doped optical fibres, the worldwide impact of our research speaks for itself. The erbium-doped fibre amplifier has taken the world by storm and plans are underway to install it in both terrestrial and undersea telecommunications trunk networks to obviate the need for electrical repeaters. Current research includes intensive studies of the spectroscopic and material properties of rare-earth-doped silica-based glasses, as well as a major initiative on compound glasses. The challenge has been to melt these glasses, determine their chemistry and solve the demanding problem of producing optical fibres from sometimes difficult new materials. Our objective is to provide tailored glasses with characteristics optimised for the production of amplifiers at a wavelength of 1.3 microns, upconvertor lasers for the production of blue light and fibre lasers at new wavelengths, particularly in the mid-IR.

A parallel area in the ORC is the rapidly-expanding area of planar glass and crystal waveguide development. Planar waveguides have the advantage that complex and stable optical circuits can be more easily fabricated. Potentially, an experiment which currently fills an optical bench could be shrunk to the size of a planar optical circuit chip. A variety of techniques are under investigation for glass and crystal thin-film deposition. To date, considerable success has been achieved in ion-exchanged rare-earth-doped glass waveguides, as well as in rare-earth indiffused lithium niobate, in channel waveguides fabricated using the ion-implantation facilities at Sussex University and in epitaxially-grown Nd:YAG. Work at UCL is underway on deposition of rare-earth-doped thin films from organo-metallic compounds.

A further rapidly-expanding area in the ORC is the generation of very short (30 femtosecond) optical pulses in fibre lasers, using passive, self-starting mode-locking. Our aim is to produce a picosecond source for soliton communication systems, as well as a general purpose "femtosecond in a box" source for laboratory and diagnostic use. This work represents a major venture into non-linearities in fibre, where the availability of our erbium-doped fibre amplifier has revolutionised the practicality of such schemes, since it can readily amplify short pulses to levels of hundreds of watts - well above the threshold of non-linear switching in fibres.

In addition to extensive work on guided-wave laser devices, the ORC undertakes work on miniature diode-laser-pumped bulk laser devices, both glass and crystal. A particular success is a ring laser with unidirectional operation enforced by the acousto-optic effect which provides a very convenient route to single-frequency operation. Diode-pumped miniature lasers have also made important steps in the area of ultra-short pulses, particularly in the case of self-mode-locked lasers, where no modulator is required. A synchronously-pumped, singly-resonant optical parametric oscillator driven by a cw mode-locked train derived from a diode-pumped laser has also been demonstrated.

A further aspect of the ORC research is the exploitation of new miniature solid-state optical sources to enable the development of previously-impractical sensors, signal-processing and measurement devices. Work is underway on distributed fibre sensors, gas sensors and optical biosensors in which collaboration with UCL has been particularly fruitful. This work is underpinned by extensive fibre and planar waveguide component research, such as the production of narrow-band Bragg-grating filters using the newly-discovered fibre photorefractive effect.