PHOTONICS

TRICKING THE LIGHT FANTASTIC

European support for photonics research dates back to the 1980s, but the research effort escalated in the 1990s following the tremendous growth of the internet. Light promises to overcome the limitations of electronics in large-scale telecommunications and everyday computers. Two decades of sustained R & D now places the spotlight on Europe.

The first laser was powered up, fired and announced to the world in 1960. It was an incredible invention, an engineering feature based on years of theoretical and experimental research. Yet according to the American Charles H Townes, an early laser researcher and Nobel laureate in physics for his fundamental work in the field, the laser was 'a solution looking for a problem'.

Half a century later, it is hard to find a problem where lasers have not been part of the answer. They are used as precision tools for research and industry and as surgical instruments in hospitals; they make holograms and microchips; and they are found in everyday devices from supermarket scanners to DVD players.

Many EU research projects funded through early Framework Programmes in the 1990s used lasers as a tool, although their refinement of laser-based technologies and other photonics components must not be ignored.

However, support for strategic photonics research began in earnest in the late 1990s with FP5, which invested EUR 55 million in photonics-related projects. This budget was doubled in FP6.

This intensive research has led to the development in Europe of the world's smallest laser for telecoms applications and a prototype of the world's brightest ever laser.

It was the massive and rapid expansion of the internet in the mid-1990s that drove the sudden increase in photonics research. It quickly became clear to the scientific community that new technologies would be required to increase the data capacity and transmission speed of the telecommunications network.

Light could be used instead of electrons to 'carry' data, much faster and more efficiently.

BLUE SKIES FOR FET

Through the 'Information society technologies' (IST) theme of FP6, a total of 49 projects were funded, all geared towards building novel photonic components and devices, including micro-scale lasers and all-optical switching systems. These components used novel materials, but were also designed to be integrated into microchips so that the worlds of photonics and electronics could work together seamlessly.

Several of the projects were funded through the 'Future and emerging technologies' (FET) programme calling for novel, 'blue skies' aspects of photonics technology.

European photonics came of age in 2005 with the launch of the European technology platform Photonics21. Since then, this powerful Europe-wide grouping has driven the EU R & D agenda and played an essential role in steering photonics research in FP7 and in shaping the future direction and priorities for research.

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Photonics21 predicts that advances in this field will push the limits of data transfer, processing and storage far beyond the limits we experience today.

Could photonics become the electronics of tomorrow? The importance of photonics for computing and processing is still uncertain, although the EU has funded research into quantum information processing and communication since FP4.

However, most experts agree that light is almost certain to replace electronics as the primary carrier for data, not just down hundreds of miles of fibre optic core, but also within most microchips.

The application of photonics is not limited to data transmission and processing. Lasers have been used in the life sciences for many years as research tools and are used increasingly in therapeutic and surgical interventions.

For example, laser-based systems are still the only technology that can identify single cells and even single molecules in tissue samples.

Photonics (and bio-photonics) will therefore play an increasingly important role in medical diagnosis and as a research tool for scientists and researchers developing new therapies. Novel lasers are also being tested in, often portable, non-invasive testing kits.

We may also see the fruits of European photonics research in our homes as EU projects continue to develop new light emitting materials. Europe has funded projects to improve high-brightness light-emitting diodes (LEDs) and drive forward the development of materials called organic light emitting diodes (OLEDs) for energy efficient lighting.

From lightening fast internet to low-energy lighting, Europe is certainly investing in its photonic future. ■

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PHOTONICS

PROJECTS IN FOCUS

For the past quarter of a century we have had tantalising glimpses of a future where light could revolutionise ICT. From photonic microchips to high-capacity fibre optic cores, European research is solving many technological challenges, at light speed.

Although light-based data transmission is fast with high bandwidth, it is also very expensive — almost half the cost of an entire optical communications system goes into photonic components and their packaging.

The PICCO project has therefore developed a suite of novel design tools, manufacturing technologies and designs for photonic integrated circuits that all aim to bring down the costs. A number of patents have been taken out by some of the PICCO partners.

The FP7 Smartiehs project is also looking to improve manufacturing in this field. It is developing a special silicon wafer that can be used to inspect other wafers and check that they have been manufactured correctly. The special probe wafer contains an array of microscopic optical sensors that can 'look' all over another wafer and confirm that it fits the design specification. The technology should make wafer inspections 100 times faster than they are today.

Two important breakthroughs by the Delila project have brought an emerging laser-based nanoscale fabrication technology out of the lab and into the real world. Researchers used a technique called laser interference lithography to 'write' nanoscale structures onto the surface of materials.

The technique can produce structures just 30 nm in size and modify features with dimensions of only 5 nm. Commercial systems based on Delila's results could start fabricating real nanotechnologies in the next two to three years.

Photonics often involves the development of new materials so the NATCO project came up with a technique that combines computer modelling and precision fabrication to create novel transparent conductive oxides (TCOs).

TCOs, which are materials that combine transparency and conductivity, qualities which are not usually found together, have multiple applications. As sensors, photovoltaics, light-emitting devices and electronically controllable films, they are found in scientific instruments, DVDs, digital cameras, mobile phones, computer displays and hundreds of other products. ■