The hidden face of nanophotonics

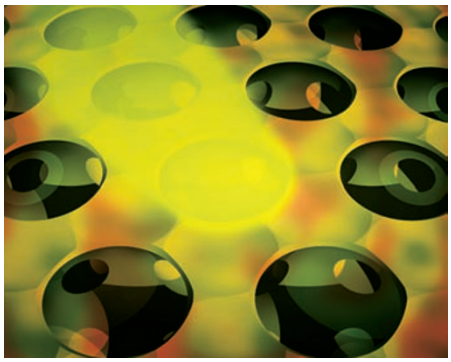
Experts in Europe have published a report that outlines the opportunities and challenges facing the emerging field of nanophotonics.

Does nanophotonics have an identity problem? Is it receiving the recognition and funding it deserves? Which commercial applications are the most likely to benefit from research in this area?

These are some of the pressing questions that were discussed by a panel of 20 experts at the Nanophotonics Foresight Workshop, held on 24–25 November 2011 at The Institute of Photonic Sciences (ICFO) in Barcelona, Spain. The Nanophotonics Europe Association — organizer of the two-day event — has now released a report that aims to aid the long-term planning of nanophotonics research and development within the EU, with particular emphasis on the application-oriented goals of the Photonics 21 initiative (www.photonics21.org). The report, which is available for download on the association's website (www.nanophotonicseurope.org), not only comments on the challenges currently faced by nanophotonics, but also highlights ten areas in which the field is expected to have a particularly disruptive impact over the next 5–10 years.

"By squeezing light down to the nanoscale to exploit optical phenomena, nanophotonics can challenge existing technological limits and help deliver superior photonic devices," comments the report. "Opportunities range from telecommunications to health and energy: photonic circuits that are not only smaller but faster and consume less energy; nano-optical sensors able to detect the chemical composition of molecules at ultralow concentrations; and new solar cell designs for enhanced light absorption."

However, despite these exciting opportunities, the report points out several



hurdles that will eventually need to be tackled. The first is the development of commercial-scale applications; although nanophotonics has indeed emerged as a booming research area, translating that research success into next-generation devices remains a challenge. The report states that although European industry is in a strong position to benefit from and exploit nanophotonics, the current connection to industry is weak. It also warns that support for curiosity-driven research is essential, and that funding mechanisms should allow for the unexpected. Another issue is associated with the field's identity; the role and value of nanophotonics is often hidden within other disciplines or technologies, and is therefore not always immediately obvious.

The report highlights ten areas in which nanophotonics is expected to have a disruptive impact over the next decade: 1) quantum optics, where nanophotonics can help build on-chip integrated optical circuitry for performing tasks in quantum information processing; 2) telecommunications, where nanophotonic circuitry can help dramatically shrink the physical size and power consumption of devices such as modulators, switches and lasers; 3) data storage, in which plasmonics can help take magnetic storage to new levels of data density through heat-assisted magnetic recording; 4) medical therapies and diagnostics, where the interaction between nanoparticles and light can be used for imaging purposes or to kill cancerous cells through localized heating or even light-induced drug delivery; 5) nanoscale imaging involving probes, optical antennas or super-lens techniques to image beyond the diffraction limit; 6) molecular-scale sensors using nanophotonic technology to offer single-molecule detection and identification; 7) nanotagging, in which metamaterials and nanostructured barcodes can be used to combat counterfeiting; 8) LEDs and solar cells, where nanostructuring can be used to optimize the emission or absorption of light; 9) new processing techniques for fabrication and lithography at higher resolutions; and 10) nanophotonic materials with custom-designed optical properties.

It is essential that European industry is aware of the potential benefits and capabilities of nanotechnology, and establishes strong links with the research community. In the USA, companies such as Intel and IBM already have strong research programmes looking at the next-generation applications of nanophotonics — silicon and carbon-based nanophotonics in particular. In Asia, firms such as Hitachi, NTT and Samsung are pursuing technologies that include plasmonic data storage, nanoscale integrated optics and colloidal quantum dot displays, for example. ❐

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