Hyperuniform disordered materials

Flexible platforms for photonic integrated circuits

Academic: *Dr Marian Florescu*

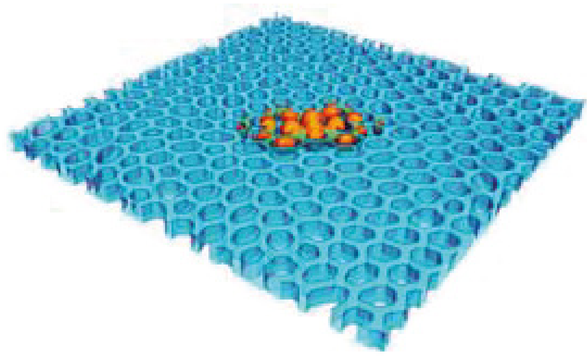
An IAA project with US company Etaphase has explored a new class of photonic materials that enables the development of photonic integrated circuits, which offer great benefits over conventional electronic circuits in terms of energy efficiency, bit rate and flexibility of design.

Unlike electrons, photons travel at the speed of light and do not interact with each other, potentially enabling tasks to be performed in parallel, saving time and money. However, until now there has been a challenge with controlling the flow of photons within a circuit in a compact and energy-efficient manner.

Researchers in Surrey's Advanced Technology Institute (ATI) collaborated with Etaphase to develop a new class of materials – known as hyperuniform disordered (HUD) materials – which would overcome this challenge, providing a viable solution for the manufacture of photonic integrated circuits. By creating a device based on a cavity structure, the team has demonstrated that the materials have fewer constraints in terms of the design of the connections and the circuit itself, enabling the manufacture of more compact circuitry. In addition, the HUD materials offer three times better temperature stability, meaning large savings in the energy needed to cool devices.

One of the most important applications for this technology will be large data centres where a photonic-based circuit solution could greatly reduce energy used and the resulting environmental impact. The research has resulted in the filing of a patent, and Etaphase is now working on commercialising the technology.

"The new materials we are proposing enable remarkable design freedom, including the realisation of waveguides with arbitrary bending angles impossible to achieve or even imagine in periodic materials, which demonstrates their potential as building blocks for precise manipulation of photons in planar optical microcircuits," says Dr Florescu. Ruth Ann Mullen, CTO of Etaphase, adds: "Surrey's very close academic collaboration with us was a critically important force-multiplier to the inclusion in Etaphase's emerging component catalogue of an electrically modulated resonant optical cavity with sub-volt sensitivity."



HUD platform supports both HUDsian and photonic crystal cavities. An isolated, purely HUDsian cavity

Another IAA-funded project is being carried out to investigate further a new class of amorphous photonic materials recently discovered at Surrey. These materials, which offer a range of useful properties, could have huge potential not only for conventional areas of structured materials, such as integrated photonic integrated circuitry, but also for applications such as heat-rejecting window films and paints to improve the energy-efficiency of buildings and vehicles.

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