New research exploits extraordinary properties of graphene

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Innovative new research led by the University of Exeter has demonstrated how the extraordinary properties of graphene can be exploited to create artificial structures that can be used to control and

manipulate electromagnetic radiation over a wide range of wavelengths.

A team of international scientists, led by Professor Geoff Nash from the University of Exeter, have engineered a remarkable new hybrid structure, or metamaterial, that possesses specific characteristics that are not found in natural materials.

The collaborative team combined nano-ribbons of graphene, in which electrons are able to oscillate backwards and forwards, together with a type of antenna called a split ring resonator.

Careful design of these two elements leads to a system which strongly interacts with electromagnetic radiation. In these experiments the team used light with very long wavelengths, far beyond what the human eye can see, to show that these new structure can be used as a type of optical switch to interrupt, and turn on and off, a beam of this light very quickly.

The collaborative international research, including experts from the University of Exeter, England, and teams led by Dr Sergey Mikhailov at the University of Augsburg, Germany, and Professor Jérôme Faist at ETH Zurich, is published in respected scientific journal, *Nature Communications*.

Professor Geoff Nash, from the University of Exeter's Department of Engineering said: "In these novel results we demonstrate a new type of structure which can be used not only as an exciting test bed to explore the underlying new science, but that could form the basis of a range of technologically important components".

The research was carried out as part of the EU FET Open Project GOSFEL , which aims to develop an entirely new laser source for applications such as gas sensing. Professor Nash currently also holds an

EPSRC in Frontier Manufacturing.

Professor Nash, who is also Director of Natural Sciences at Exeter added: "One of the key characteristics of our structure is that it has the effect of focussing the electromagnetic radiation into an area much smaller than its wavelength. This could potentially lead to new ways of undertaking ultra-high resolution spectroscopy of, for example, bio molecules. Working with colleagues in Biosciences we are already starting to explore some of these effects, with undergraduates from our innovative interdisciplinary Natural Sciences programme, and postgraduates from the Exeter EPSRC Centre for Doctoral Training in Metamaterials."

More information: Peter Q. Liu et al. Highly tunable hybrid metamaterials employing split-ring resonators strongly coupled to graphene surface plasmons, *Nature Communications* (2015). DOI: 10.1038/ncomms9969

Provided by University of Exeter