# Study suggests that silicon could be a photonics game-changer

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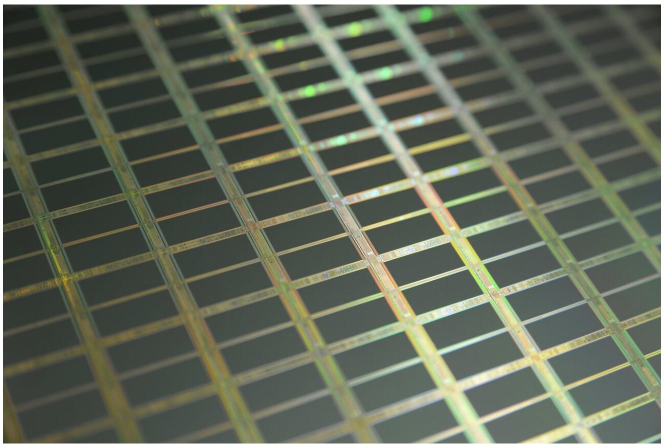

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New research from the University of Surrey has shown that silicon could be one of the most powerful materials for photonic informational manipulation—opening up new possibilities for the production of lasers and displays.

While computer chips' extraordinary success has confirmed silicon as the prime material for electronic information control, silicon has a reputation as a poor choice for photonics; there are no commercially available silicon light-emitting diodes, lasers or displays.

Now, in a paper published by *Light: Science and Applications* journal, a Surrey-led international team of scientists has shown that silicon is an outstanding candidate for creating a device that can control multiple light beams.

The discovery means that it is now possible to produce silicon processors with built-in abilities for light beams to control other beams—boosting the speed and efficiency of electronic communications.

This is possible thanks to the wavelength band called the far-infrared or terahertz region of the electromagnetic spectrum. The effect works with a property called a nonlinearity, which is used to manipulate laser beams—for example, changing their color. Green laser pointers work this way: they take the output from a very cheap and efficient but invisible infrared laser diode and change the color to green with a nonlinear crystal that halves the wavelength.

Other kinds of nonlinearity can produce an output beam with a third of the wavelength or be used to redirect a laser beam to control the direction of the beam's information. The stronger the nonlinearity, the easier it is to control with weaker input beams.

The researchers found that silicon possesses the strongest nonlinearity of this type ever discovered. Although the study was carried out with the crystal being cooled to very low cryogenic temperatures, such strong nonlinearities mean that extremely weak beams can be used.

Ben Murdin, co-author of the study and Professor of Physics at the University of Surrey, said, "Our finding was lucky because we weren't looking for it. We were trying to understand how a very small number of phosphorus atoms in a silicon crystal could be used for making a quantum computer and how to use light beams to control quantum information stored in the phosphorus atoms.

"We were astonished to find that the phosphorus atoms were re-emitting light beams that were almost as bright as the very intense laser we were shining on them. We shelved the data for a couple of years while we thought about proving where the beams were coming from. It's a great example of the way science proceeds by accident, and also how pan-European teams can still work together very effectively."

**More information:** Nils Dessmann et al, Highly efficient THz four-wave mixing in doped silicon,

*Light: Science & Applications* (2021). DOI: 10.1038/s41377-021-00509-6

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