Transition metal dichalcogenides could increase computer speed, memory

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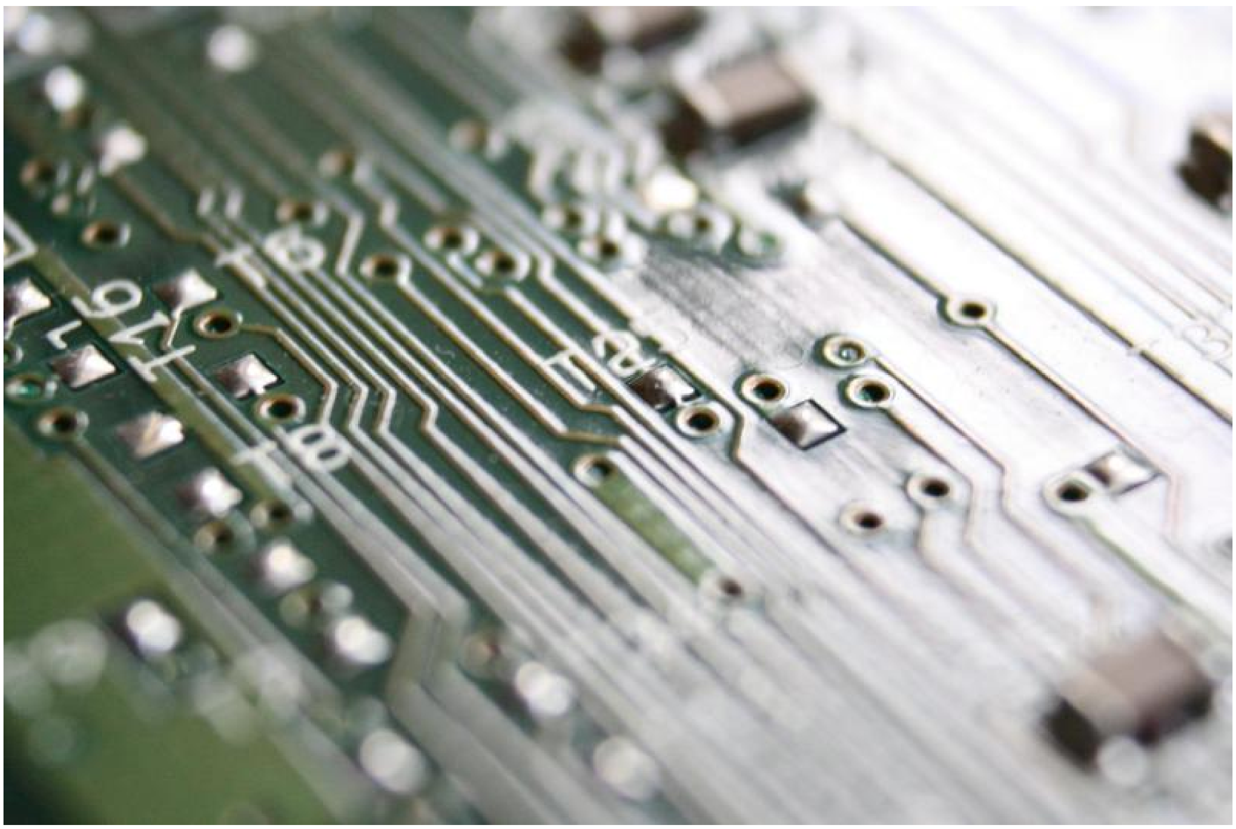

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Transition metal dichalcogenides (TMDCs) possess optical properties that could be used to make computers run a million times faster and store information a million times more energy-efficiently, according to a study led by Georgia State University.

Computers operate on the time scale of a fraction of a nanosecond, but the researchers suggest constructing computers on the basis of TMDCs, atomically thin semiconductors, could make them run on the femtosecond time scale, a million times faster. This would also increase computer memory speed by a millionfold.

"There is nothing faster, except light," said Dr. Mark Stockman, lead author of the study and director of the Center for Nano-Optics and a Regents' Professor in the Department of Physics and Astronomy at Georgia State. "The only way to build much faster computers is to use optics, not electronics. Electronics, which is used by current computers, can't go any faster, which is why engineers have been increasing the number of processors. We propose the TMDCs to make computers a million times more efficient. This is a fundamentally different approach to information technology."

The researchers propose a theory that TMDCs have the potential to process information within a couple of femtoseconds. A femtosecond is one millionth of one billionth of a second. A TMDC has a hexagonal lattice structure that consists of a layer of transition metal atoms sandwiched between two layers of chalcogen atoms. This hexagonal structure aids in the computer processor speed and also enables more efficient information storage. The findings are published in the journal *Physical Review B*.

The TMDCs have a number of positive qualities, including being stable, non-toxic, thin, light and mechanically strong. Examples include molybdenum disulfide (MOS_2) and tungsten diselenide (WSe_2). TMDCs are part of a large family called 2-D materials, which is named after their extraordinary thinness of one or a few atoms. In this study, the researchers also established the optical properties of the TMDCs, which allow them to be ultrafast.

In the hexagonal lattice structure of TMDCs, electrons rotate in circles in different states, with some electrons spinning to the left and others turning to the right depending on their position on the hexagon. This motion causes a new effect that is called topological resonance. Such an effect allows one to read, write or process a bit of information in only a few femtoseconds.

There are numerous examples of TMDCs, so in the future, the researchers would like to determine the best one to use for computer technology.

More information: S. Azar Oliaei Motlagh et al. Femtosecond valley polarization and topological resonances in transition metal dichalcogenides, *Physical Review B* (2018). DOI: 10.1103/PhysRevB.98.081406

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