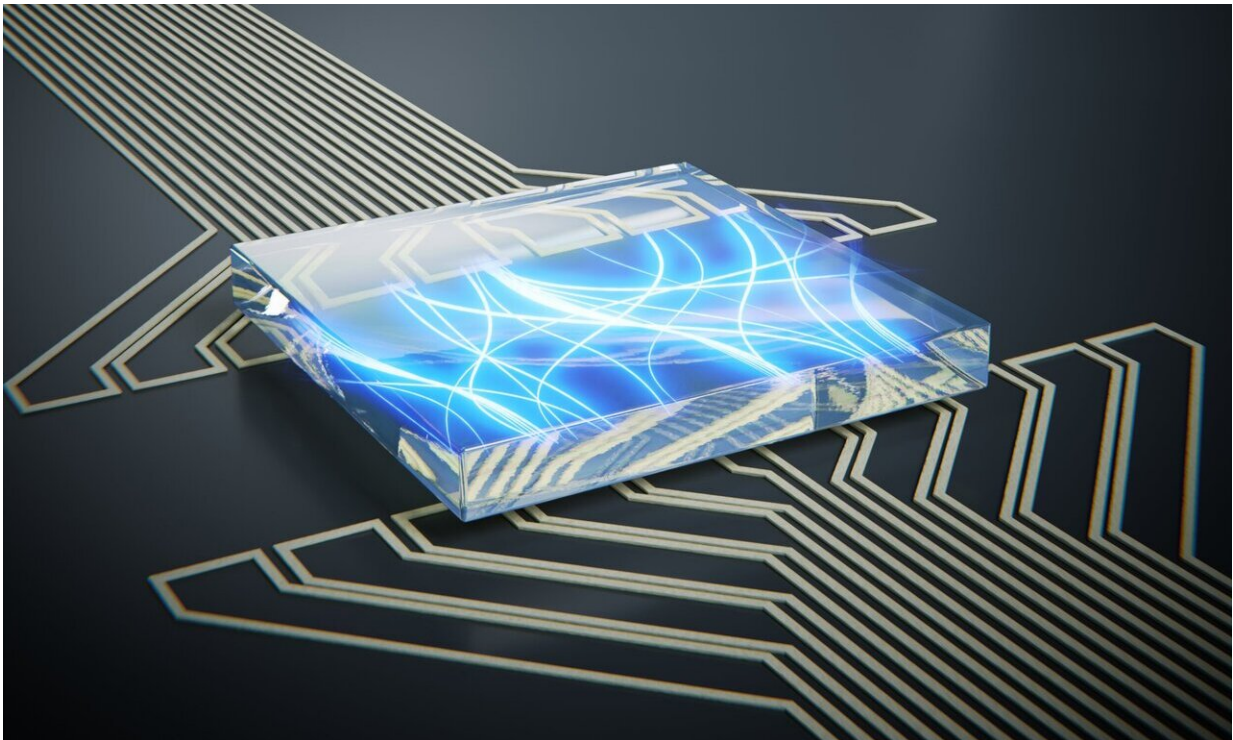


Researchers create MRI-like technique for imaging magnetic waves

November 13 2020, by Jerwin De Graaf



Credit: TU Delft/Scixel

A team of researchers from Delft University of Technology (TU Delft), Leiden University, Tohoku University and the Max Planck Institute for the Structure and Dynamics of Matter has developed a new type of MRI scanner that can image waves in ultrathin magnets. Unlike electrical currents, these so-called spin waves produce little heat, making them

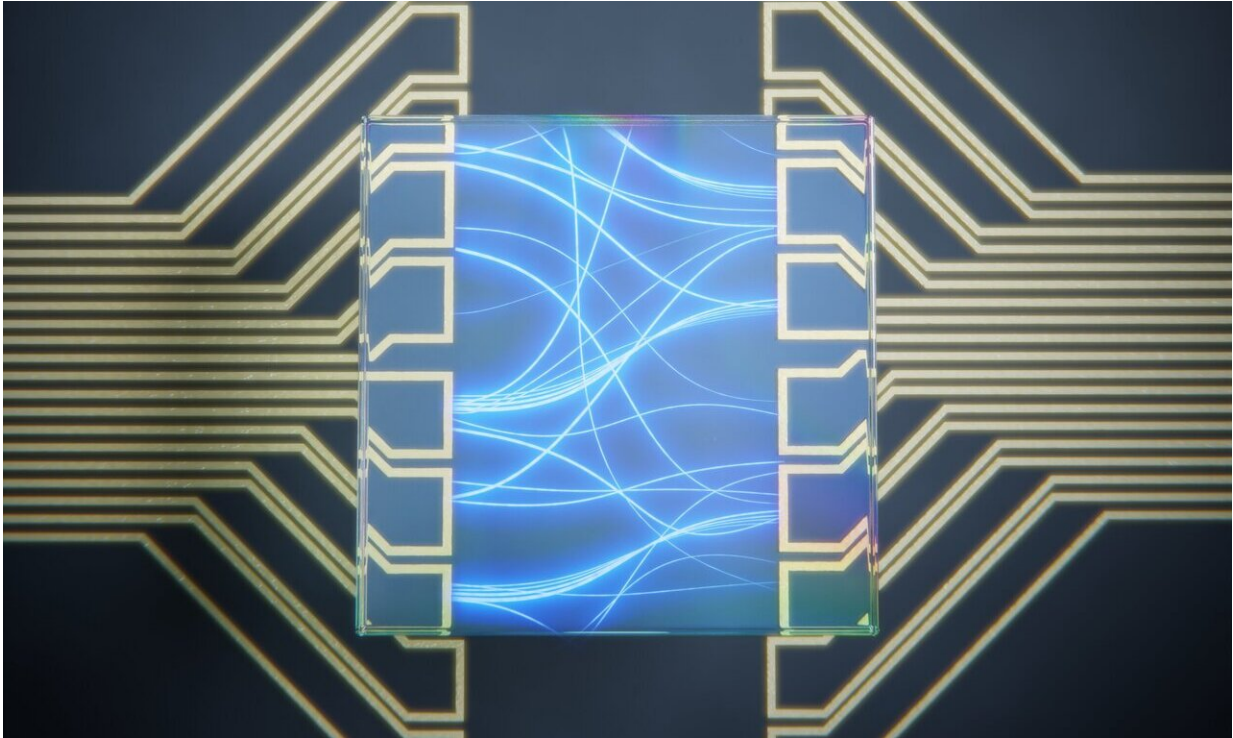
promising signal carriers for future green ICT applications.

MRI scanners can look into the human body in a non-invasive manner. The scanner detects the magnetic fields radiated by the atoms inside, which makes it possible to study the health of organs even though they are hidden underneath thick layers of tissue.

The non-invasive, see-through power of MRI is desirable for many research fields and industries. It could be particularly useful as an imaging tool in nanotechnology and the chip industry. Being able to detect signals in computer chips and other nanodevices would facilitate optimizing their performance and reducing their heat production. However, the millimeter resolution of conventional MRI is insufficient to study chip-scale devices. A team of researchers led by TU Delft have now developed a new method for sensing [magnetic waves](#) at the sub-micrometer scale.

NV center

The MRI system made by the Delft researchers makes use of a special lattice defect in the crystal structure of diamond. This defect—known as nitrogen-vacancy (NV) center—consists of a nitrogen atom sitting next to an empty site in the diamond carbon lattice. "Such an NV center is essentially an atom-sized magnet that is extremely sensitive to magnetic fields," TU Delft researcher Toeno van der Sar explains. "As such, NV centers enable high-resolution imaging of the magnetic structure of a sample."



Credit: TU Delft/Scixel

Excited spin waves

Spin [waves](#) are waves in magnetic materials that are central to the behavior of magnets. They are promising as information carriers because they produce little heat. Their wave nature makes it possible to build logic devices that perform computational tasks using wave interference.

Being able to see the waves is crucial for designing spin-wave devices "To image these waves, we used a diamond chip in which we created a layer of NV centers," Van der Sar explains. "We placed this chip on top of a thin magnetic film in which we excited spin waves using electrodes and microwave currents. The NV centers pick up the magnetic fields generated by the spin waves, enabling high resolution spin-wave

imaging."

The researchers have demonstrated that spin-wave MRI allows spin waves to be imaged through opaque materials such as the metal wiring on a chip. Furthermore, the technique has the sensitivity to detect spin waves in magnets that are only a single atom thick. Van der Sar says, "As there is currently a push in using ultrathin magnets to create logic devices at the smallest scale, this imaging technique will aid that development."

More information: Iacopo Bertelli et al. Magnetic resonance imaging of spin-wave transport and interference in a magnetic insulator, *Science Advances* (2020). [DOI: 10.1126/sciadv.abd3556](https://doi.org/10.1126/sciadv.abd3556)

Provided by Delft University of Technology

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