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Portable maser realized through miniaturization tech, room-temperature gain material

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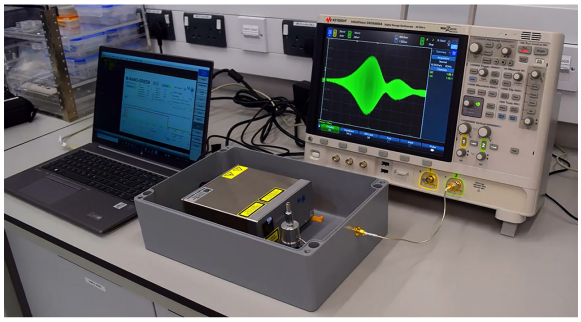
The device, weighing just a few kilograms, can produce coherent microwave light and could be applied in medical and communications fields.



A maser is a device capable of emitting coherent light at microwave frequencies, similar to the behavior of a laser at optical frequencies. Despite their similarities, laser devices have become very portable and permeate our daily lives, while masers are still large and mostly stationary, confining them to research laboratories.

Ng et al. developed a new maser design that significantly reduces the size of the device, fitting all components into a space approximately the size of a shoebox. This type of small-scale device could boost microwave signals for medical and communications technologies such as MRI machines and cell towers at an affordable cost.

Their design relies on a modern gain material using pentacene, a chain of five benzene rings that can “mase” at room temperatures.

“Masers always needed very cold temperatures, and they usually needed vacuums, which made them really heavy,” said author Wern Ng. “We managed to shrink it down to only 5 kilograms, with no cooling needed, no need for any vacuum, and all solid state.”

One of the biggest challenges the team faced was how to miniaturize the pump source. While using a room-temperature gain material eliminated the need for cooling, existing designs still employed a large, high-energy pump. The authors were able to produce those high energies using a small, portable laser source that significantly reduced the overall size of the device.

The authors are next planning to explore constructing smaller masers using other types of gain material.

“We have shown that we can successfully miniaturize the pentacene maser,” said Ng. “Our next task is to miniaturize room temperature masers with different gain media such as diamond.”

Source: “`Maser-in-a-shoebox': a portable plug-and-play maser device at room-temperature and zero magnetic-field,” by Wern Ng, Yongqiang Wen, Max Attwood, Daniel C. Jones, Mark Oxborrow, Neil McN. Alford, and Daan M. Arroo, *Applied Physics Letters* (2024). The article can be accessed at https://doi.org/10.1063/5.0181318.