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Photonics: Cooking up hot lasers

An optically pumped plasmonic structure promises ultracompact lasers for integrated photonic circuits.

Despite recent advances in laser miniaturization, conventional lasers are limited by the laws of optics to dimensions on the order of half the wavelength of the laser light. This typically corresponds to laser dimensions on the order of hundreds to thousands of nanometers — far larger than the sub-100 nm size of modern electronic devices.

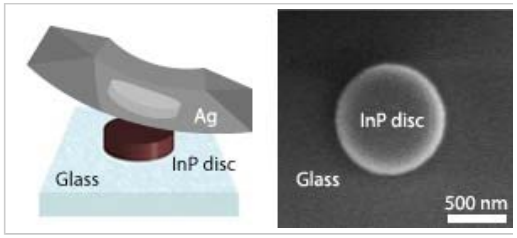

Fig. 1: Schematic illustration (left) and scanning electron microscopy image (right) of a nanopan laser, consisting of a silver (Ag) coated indium phosphide (InP) nanodisk on a glass substrate.

Researchers from Korea University in Seoul, in collaboration with colleagues from a number of institutions in Korea, France and the USA, have now demonstrated a new type of lithographically fabricated laser that beats the limits of conventional optics[1]. "These lasers make it possible to miniaturize nanophotonic devices, which could lead to ultra-compact integration into photonic systems," says Hong-Gyu Park from the research team.

Even though the laws of optics place stringent limits on the minimum size of optical instruments, techniques have been developed that circumvent such restrictions. Most of these approaches make use of plasmonic resonances on the surfaces of metals. These 'surface plasmons' are electron resonances that act as antennas, modifying light on length scales much smaller than its wavelength.

The researchers' 'nanopan' laser makes use of the plasmonic effects in small disks of indium phosphide, a semiconducting light-emitter, coated side and bottom with a thin layer of near-atomically smooth silver (Fig. 1). When the disk is excited with an external laser, it emits light that is then confined within the disk through the plasmonic properties of the silver coating. At high laser 'pump' intensities, the build-up of light intensity is strong enough to achieve lasing. The use of plasmonic effects means that the device can be made very small. In the researchers' example, the overall volume of the disk is much smaller than the volume required for a conventional optics configuration.

Plasmon lasers have been demonstrated before, but this new design exhibits several advantages. The top-down fabrication of the lasers, as well as their size, makes them good candidates for integrated photonic circuits, particularly if the lasers can be excited mor efficiently. "We would like to demonstrate an electrically driven plasmonic laser. Such a stand-alone, fast, ultrasmall laser that operates with an extremely small power budget would be the ultimate coherent light source," says Park.

Reference

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