World's Tiniest Lens Developed by Scientist

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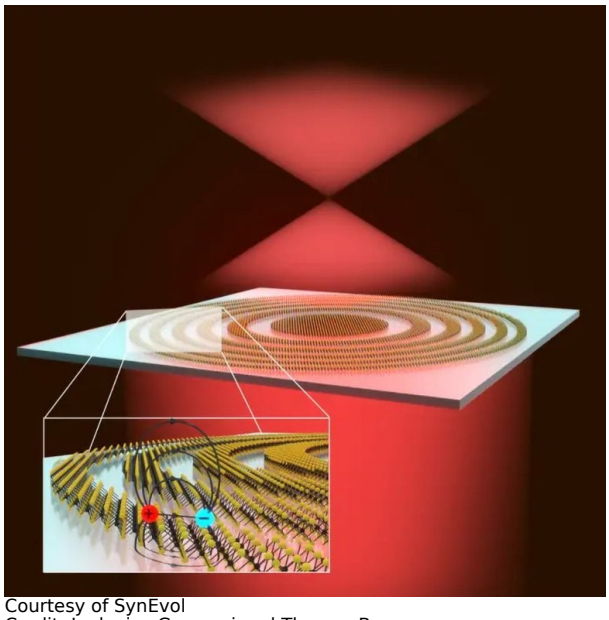

Courtesy of SynEvol
Credit: Ludovica Guarneri and Thomas Bauer

Usually, lenses control light by curving their surfaces. But using quantum phenomena to bend and concentrate light, scientists at Stanford University and the University of Amsterdam have created a flat lens that is only three atoms thick. In the future, augmented reality glasses may include this creative lens.

Most likely, when you think of a lens, you picture a piece of curved glass. With this kind of lens, we may make objects appear closer or larger than they actually are because light is refracted, or bent, both when it enters and exits the glass. For over two millennia, curved lenses have been in use by humans, enabling them to better see, uncover microscopic species, and analyze the motions of far-off planets and stars.

A alternative tack was taken by Ludovico Guarneri, Thomas Bauer, and Jorik van de Groep of the University of Amsterdam, along with associates from Stanford University in California. A half-millimeter wide flat lens measuring only 0.0000006 millimeters, or 0.6 nanometers, thick was created by them using a single layer of tungsten disulfide (WS2, for short). It is now the smallest lens on Earth as a result!

Instead of depending on a curved form, the lens is composed of WS2 rings that are concentric and have gaps between them. This lens, also known as a "zone plate lens" or "Fresnel lens," concentrates light by diffraction as opposed to refraction. The focal length of the lens is determined by the size and spacing between the rings in relation to the wavelength of light that strikes it. This design centers on red light at a distance of 1 mm from the lens.

This lens is special in that it uses quantum phenomena in WS2 to achieve its focusing efficiency. The material may effectively absorb and re-emit light at particular wavelengths thanks to these phenomena, which gives the lens an inherent advantage in performing better at these wavelengths.

Here's how this quantum improvement functions. WS2 first absorbs light by elevating an electron's energy state. Owing to the material's incredibly thin structure, a "exciton" is created when a negatively charged electron and the positively charged "hole" it leaves in the atomic lattice are drawn to one another by electrostatic forces. The electron and hole combine to form a light source, causing these excitons to swiftly vanish once more. The efficiency of the lens is enhanced by this reemitted light.

For the precise light wavelengths that the excitons emitted, the scientists found a definite peak in lens efficiency. The effect is already noticeable at ambient temperature, but cooling the lenses increases their efficiency even further. This is due to the fact that excitons function best at lower temperatures.

The fact that most light goes through the lens undamaged even though a little amount of it creates a dazzling focal point is another one of its special qualities. Although this can seem like a drawback, it actually creates new opportunities for application in future technologies. "A tiny portion of the light can be tapped to gather data, but the lens can be employed in situations when the vision through it shouldn't be obstructed. This makes it ideal for wearing glasses, like those used for augmented reality, says one of the paper's authors, Jorik van de Groep.

The current focus of the research is on developing and testing more intricate and multipurpose optical coatings whose functions, including light focusing, can be electrically altered. According to Van de Groep, "we can change the refractive index of the material by applying a voltage because excitons are very sensitive to the charge density in the material." Excitonic materials have a promising future!