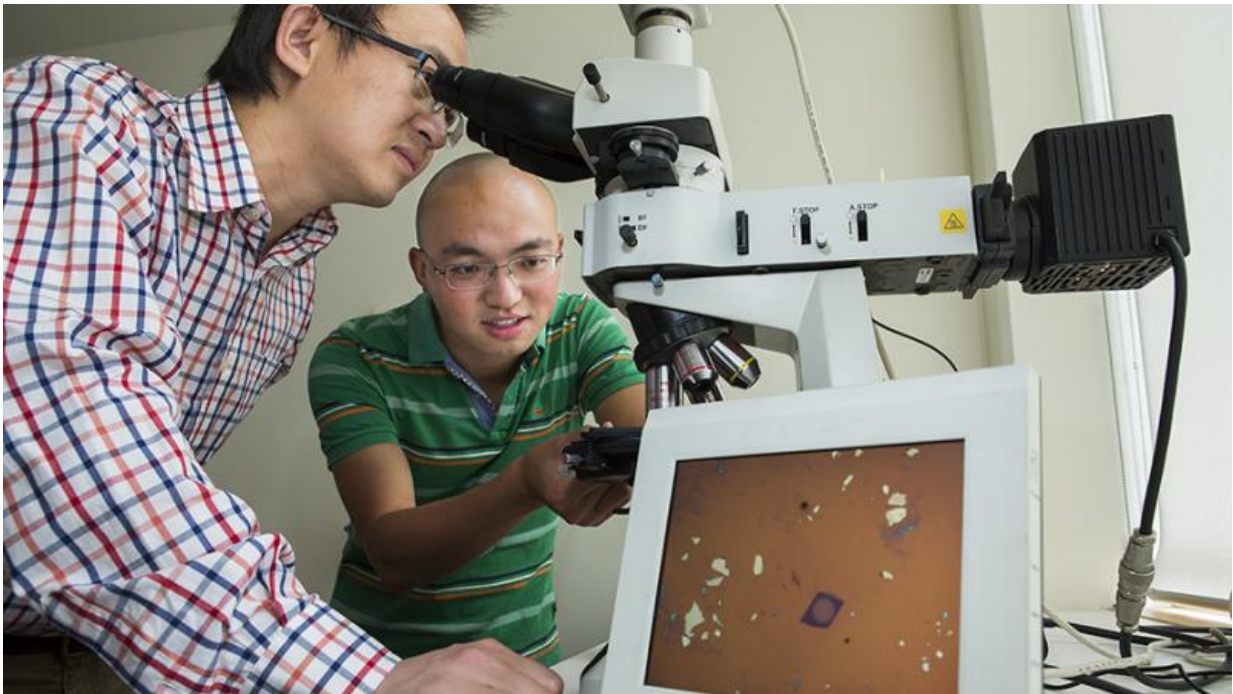


World's thinnest lens to revolutionize cameras

March 11 2016



Larry Lu (left), and Jiong Yang with the lens shown on screen. Credit: Stuart Hay, ANU

Scientists have created the world's thinnest lens, one two-thousandth the thickness of a human hair, opening the door to flexible computer displays and a revolution in miniature cameras.

Lead researcher Dr Yuerui (Larry) Lu from The Australian National

University (ANU) said the discovery hinged on the remarkable potential of the molybdenum disulphide crystal.

"This type of material is the perfect candidate for future flexible displays," said Dr Lu, leader of Nano-Electro-Mechanical System (NEMS) Laboratory in the ANU Research School of Engineering.

"We will also be able to use arrays of micro lenses to mimic the compound eyes of insects."

The 6.3-nanometre lens outshines previous ultra-thin flat lenses, made from 50-nanometre thick gold nano-bar arrays, known as a metamaterial.

"Molybdenum disulphide is an amazing crystal," said Dr Lu

"It survives at high temperatures, is a lubricant, a good semiconductor and can emit photons too.

"The capability of manipulating the flow of [light](#) in atomic scale opens an exciting avenue towards unprecedented miniaturisation of optical components and the integration of advanced optical functionalities."

Molybdenum disulphide is in a class of materials known as chalcogenide glasses that have flexible electronic characteristics that have made them popular for high-technology components.



JiongYang examines the lens (purple circle on screen). Credit: Stuart Hay, ANU

Dr Lu's team created their lens from a crystal 6.3-nanometres thick - 9 atomic layers - which they had peeled off a larger piece of molybdenum disulphide with sticky tape.

They then created a 10-micron radius lens, using a focussed ion beam to shave off the layers atom by atom, until they had the dome shape of the lens.

The team discovered that single layers of molybdenum disulphide, 0.7 nanometres thick, had remarkable optical properties, appearing to a light beam to be 50 times thicker, at 38 nanometres. This property, known as optical path length, determines the phase of the light and governs interference and diffraction of light as it propagates.

"At the beginning we couldn't imagine why molybdenum disulphide had such surprising properties," said Dr Lu.

Collaborator Assistant Professor Zongfu Yu at the University of Wisconsin, Madison, developed a simulation and showed that light was bouncing back and forth many times inside the high [refractive index](#) crystal layers before passing through.

Molybdenum disulphide crystal's refractive index, the property that quantifies the strength of a material's effect on light, has a high value of 5.5. For comparison, diamond, whose high refractive index causes its sparkle, is only 2.4, and water's refractive index is 1.3.

This study is published in the Nature serial journal *Light: Science and Applications*.

Provided by Australian National University

Citation: World's thinnest lens to revolutionize cameras (2016, March 11) retrieved 2 May 2024 from <https://phys.org/news/2016-03-world-thinnest-lens-revolutionize-cameras.html>

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