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Plastic eye mimics octopus vision

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Onion-like layers create flexible, lightweight lens.

A lens resembling an octopus eye has been created by US researchers. The sphere consists of hundreds of thousands of layers of plastic and could revolutionize cameras, telescopes and spectacles.

Traditional glass lenses use a curved surface to focus incoming light towards a central point. The stronger the lens, the more curved its surface must be and therefore the thicker and heavier it is. In nature, eyes avoid this problem by using materials whose density varies in a certain way.

Light is bent, or refracted, when it travels between two substances that have different densities (or refractive indices), such as air and water. The greater the difference between the two materials, the more the light is refracted. So a flat object that has a greater refractive index towards its edges can focus light like a curved lens.

Many biological lenses consist of up to hundreds of thousands of nanolayers, each of which has a slightly different refractive index. The layers form a smooth density gradient that helps to focus light.

In human eyes, this lens is made up of about 22,000 layers. But animals that live in water, which has a high refractive index compared with air, need stronger lenses. The octopus eye, for example, can focus light five times more strongly than a human eye.

Film stars

Eric Baer of Case Western Reserve University in Cleveland, Ohio, and his team at the Naval Research Laboratory in Washington DC set out to mimic the octopus's ability with a synthetic lens.

They created plastic films that were 50 micrometres thick and consisted of roughly 6,000 nanolayers of two different polymers, either poly (methylmethacrylate) or poly (styreneacrylonitrile). These polymers have different refractive indices, so by varying the number of polymer nanolayers in each film, the researchers created 100 films, each of which had a refractive index that differed from the next by 1%.

When stacked and formed into a sphere, the films created an eye with a focusing ability equivalent to that of the octopus eye. Baer is optimistic, however, that as the technique is developed, they will be able to create even more powerful lenses. "It's possible to create almost any refractive index," he says.

The researchers described their work last week at a meeting of the Materials Research Society, in Boston, Massachusetts.

Soft touch

There are several practical advantages to this type of lens. Glass lenses of a comparable strength would weigh almost four times as much. And a polymer lens is more flexible: the focus can be tweaked just by altering a few of the nanolayers.



Thousands of nanolayers help octopus eyes to focus underwater.

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Eventually the researchers plan to use a softer plastic that will make it easy to shift the focus of the lens by simply squeezing it. "You can change the refractive index fast, easily and with cheap materials," notes biomimetics expert Mehmet Sarikaya, of the University of Washington in Seattle.

Future applications include lightweight lenses that can be focused remotely. These could be used for unmanned aerial vehicles and missile guidance, which will please the research project's sponsor, the Defense Advanced Research Projects Agency.

But the technology could also benefit human vision. Baer has already used his nanolayers to make himself a pair of glasses; they meet his prescription, despite being absolutely flat.

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