



## Tunable, Silicon-Based Fresnel Lenses

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**WARF: P140128US01**

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**The Wisconsin Alumni Research Foundation (WARF) is seeking commercial partners interested in developing a Fresnel zone plate that has adjustable focal length and is easily integrated with electronic circuits.**

### Overview

A Fresnel lens or 'zone plate' is a type of compact lens made of concentric rings that alternate between opaque and transparent materials. The design is lighter and smaller than conventional lenses. Given their size and flat surface, Fresnel lenses are attractive for miniaturized optical systems and integrated optics.

Problematically, typical Fresnel lenses have fixed focal lengths that cannot be adjusted, which limits their usefulness. A new design incorporating carbon nanotube forests was recently developed to improve focusing capabilities, allowing the lenses to perform more efficiently in optical data transfer and communications systems. Unfortunately, the fabrication process is expensive and heat intensive, and the lenses are tough to integrate with silicon-based electronic circuits.

### The Invention

UW–Madison researchers have developed a new, silicon-based Fresnel lens that is simple to manufacture and has an adjustable focal length.

The lens is made of transparent and opaque rings. The set of opaque rings is etched with tightly spaced silicon nanowires. The structure is set on an elastic plate that can stretch to change the focal length of the lens.

### Applications

- Optical interconnects, micro optics and chip-to-chip communications
- Miniaturized optical systems
- Integration into devices like cell phone cameras

### Key Benefits

- Tunable and simple to manufacture
- Easy to integrate with electronic circuits
- Low cost
- No reliability or packaging concerns, unlike liquid-based lenses
- Straightforward to control

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### Stage of Development

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The researchers successfully developed and experimented with Fresnel zone plates made of silicon nanowires on a flexible and stretchable PDMS substrate. An array of microscale lenses, wrapped on a curved surface, captured images with wide field of view as large as 175°. Fresnel lenses on flexible substrate were actuated mechanically to vibrate and in turn, scan optical focus and control the depth of imaging. The lenses were installed in a commercial microscope to capture images with high-resolution.

## Additional Information

### For More Information About the Inventors

- [Hongrui Jiang](#)

### Related Technologies

- [WARF reference number P05131US describes hydrogel-based microlenses with adjustable focal lengths.](#)

### Publications

- [Read a news story about this technology.](#)
- [Read a news story about this technology.](#)

### Tech Fields

- [Analytical Instrumentation, Methods & Materials : Optics](#)

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