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Non-Confidential Description - PSU No. 3580
"Liquid Gradient Refractive Index (L-GRIN) Lens"

Keywords:

Liquid lens, tunable lens, optofluidic, micro lens, gradient refractive index, GRIN lens, optical fiber, L-GRIN, endoscope

Links:

Inventor website

Related Publication

US Patent 8,320,049
US Patent 8,564,885

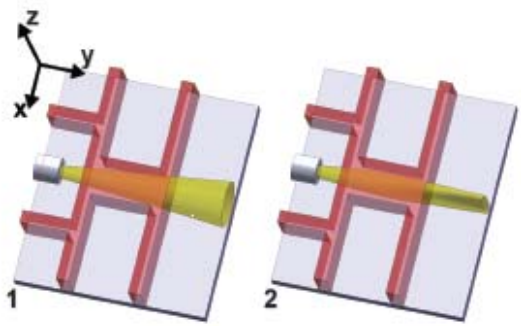

Fig 1: Schematic of the L-GRIN lens in translation mode, showing (1) no focus and (2) a large focal distance.

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Background

Tunable microlenses have proven to be crucial components for incorporating advanced functionalities into microfluidic or lab-on-a-chip systems. A tunable microlens adaptively reshapes the input light, adjusting its focal position, intensity, beam profile, and even propagation direction. Such fine tuning of the light is critical for realizing a broad spectrum of lab-on-a-chip applications such as flow cytometry, single molecule detection, and on-chip optical tweezers. These microlenses have proven useful in medical diagnosis and lab-on-a-chip devices. However, the design of the ultra-small tunable microlens has been limited by the constraints of lens size and complex lens tuning mechanisms. The difficulties in creating and sustaining an in-plane tunable classic refractive microlens challenge us to search for alternative solutions.

Invention Description

The disclosed invention is an ultra-small tunable microlens which provides variable focusing and scanning within a limited space. The invention, the Liquid Gradient Refractive Index (L-GRIN) lens, makes it possible to achieve both varying focal length and beam direction using a lens that is less than 1×1 mm^2. The L-GRIN lens takes advantages of refractive index distribution in liquid to variably focus light, and therefore does not involves any complex mechanical or electrical parts in other tunable microlenses. More importantly, with precise microfluidic manipulation, one can change not only the focal distance of the L-GRIN lens by adjusting the refractive index contrast (the difference between the maximum and minimum in the gradient), but also the direction of output light by shifting the optical axis. Such a tunable microlens with two degrees of freedom enables an unprecedented flexibility for on-chip manipulation of light. The system can be used in ultra-small diagnostic medical probes such as endoscopes or light focusing elements in lab-on-a-chip devices.

Advantages/Applications

- Simplifies the lens tuning system using optofluidics, allowing for a smaller lens (1×1 mm^2)
- Offers two degrees of freedom: adjustment in focal distance as well as direction of light output

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