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The Director

of the United States Patent and Trademark Office has received an application for a patent for a new and useful invention. The title and description of the invention are enclosed. The requirements of law have been complied with, and it has been determined that a patent on the invention shall be granted under the law.

Therefore, this United States

Patent

grants to the person(s) having title to this patent the right to exclude others from making, using, offering for sale, or selling the invention throughout the United States of America or importing the invention into the United States of America, and if the invention is a process, of the right to exclude others from using, offering for sale or selling throughout the United States of America, products made by that process, for the term set forth in 35 U.S.C. 154(a)(2) or (c)(1), subject to the payment of maintenance fees as provided by 35 U.S.C. 41(b). See the Maintenance Fee Notice on the inside of the cover.

Katherine Kelly Vidal

DIRECTOR OF THE UNITED STATES PATENT AND TRADEMARK OFFICE

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(12) **United States Patent**
Luo et al.

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(54) **METASURFACE BASED DEVICE FOR GENERATING ABRUPT AUTOFOCUSING BEAM**

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(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 443 days.

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CPC ***G02B 1/002*** (2013.01); ***G02B 5/1814*** (2013.01); ***G02B 5/3083*** (2013.01); *G02B 2207/101* (2013.01)

(58) **Field of Classification Search**

CPC G02B 1/002; G02B 5/1814; G02B 5/3083; G02B 2207/101; G02B 5/1809; G02B 27/42–425; G02B 2005/1804

See application file for complete search history.

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(Continued)

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(57) **ABSTRACT**

The present invention provides a device for generating an abrupt autofocusing beam, comprising a light source module, a metasurface phase modulating element, and a focus lens, wherein the light source module generates an incident light beam, the metasurface modulating element has a first optical receiving surface for receiving the incident light beam, and an optical emitting surface having a plurality of dielectric nano-structures formed thereon for modulating the incident light beam into a diffracted light beam wherein the plurality of nano-structures respectively corresponding to optical-phase mask patterns, and the focus lens is arranged at a side of the optical receiving surface for performing optical Fourier transform of the diffracted light beam obtained from the metasurface phase modulating element.

18 Claims, 6 Drawing Sheets