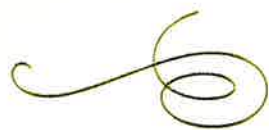


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The Director

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



US011684404B2

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

(10) **Patent No.:** **US 11,684,404 B2**
(45) **Date of Patent:** **Jun. 27, 2023**

(54) **METHODS AND DEVICES FOR OPTOACOUSTIC STIMULATION**

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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 0 days.

(21) Appl. No.: **17/690,948**

(22) Filed: **Mar. 9, 2022**

(65) **Prior Publication Data**

US 2022/0287758 A1 Sep. 15, 2022

Related U.S. Application Data

(60) Provisional application No. 63/177,029, filed on Apr. 20, 2021, provisional application No. 63/158,566, filed on Mar. 9, 2021.

(51) **Int. Cl.**
A61B 18/04 (2006.01)
B01J 19/10 (2006.01)

(Continued)

(52) **U.S. Cl.**
CPC **A61B 18/04** (2013.01); **A61B 5/0095** (2013.01); **A61B 18/26** (2013.01); **B01J 19/10** (2013.01);

(Continued)

(58) **Field of Classification Search**
CPC A61B 18/04; A61B 5/0095; A61B 18/26; A61B 5/0035; A61B 5/0059;
(Continued)

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(57) **ABSTRACT**

A tapered fiber optoacoustic emitter includes a nanosecond laser configured to emit laser pulses and an optic fiber. The optic fiber includes a tip configured to guide the laser pulses. The tip has a coating including a diffusion layer and a thermal expansion layer, wherein the diffusion layer includes epoxy and zinc oxide nanoparticles configured to diffuse the light while restricting localized heating. The thermal expansion layer includes carbon nanotubes (CNTs) and Polydimethylsiloxane (PDMS) configured to convert the laser pulses to generate ultrasound. The frequency of the ultrasound is tuned with a thickness of the diffusion layer and a CNT concentration of the expansion layer.

23 Claims, 53 Drawing Sheets

