Agenzia Spaziale Italiana	**TRACCE PROVA COLLOQUIO** **BANDO N. 31/2021**	**Pag. 1 di 1**

Bando n. 31/2021– Selezione pubblica, per titoli ed esami, volta al reclutamento di n. 3 unità di personale, nel profilo di Ricercatore, del livello professionale III – 1^ fascia stipendiale, da assumere con contratto di lavoro a tempo pieno e determinato, della durata di 1 anno – rinnovabile - nell'ambito del progetto PON "QUANCOM -Sviluppo di sistemi e tecnologie quantistiche per la sicurezza informatica in reti di comunicazione".

Busta n. 5

1- Il candidato individui nel suo curriculum le esperienze che ritiene maggiormente attinenti al profilo e sulla base di queste illustri quale contributo ritiene di poter dare alle attività dell'ASI.

2- Il candidato dopo aver scelto uno tra i seguenti apparati:
-Amplificatore Lock-in
-Time tagger
Ne descriva il funzionamento e ne contestualizzi l'impiego in un esperimento di metrologia e/o spettroscopia e/o quantum technologies.

3- Discussione dell'elaborato scritto, redatto dal candidato, su aspetti indicati dalla commissione.

4- Il candidato illustri cosa è il DVSS (Documento di Visione Strategica per lo Spazio) e in quale rapporto è con la programmazione operativa delle attività

Busta 5 All. 1

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Article

Ultra-Short Dual-Core Photonic Crystal Fiber Polarization Beam Splitter with Round Lattice and As_2S_3-Filled Center Air Hole

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Abstract: A circular ultra-short As_2S_3 filled double-core photonic crystal fiber polarization beam splitter is proposed. The finite element method is used to study the performance of the designed photonic crystal fiber polarization beam splitter. By filling high refractive index As_2S_3 into the central air hole, the coupling performance of the double-core PCF is improved. By optimizing geometric parameters, the splitting length of the circular beam splitter can be as short as 72.43 μm, and the extinction ratio can reach −151.42 dB. The high extinction ratio makes the circular polarization beam splitter have a good beam splitting function. The designed circular double-core photonic crystal fiber has the same cladding pore diameter, which is easier to prepare than other photonic crystal fibers with complex pore structure. Due to the advantages of high extinction ratio, extremely short beam splitting function and simple structure, the designed polarization beam splitter will be widely used in all-optical networks and optical device preparation.

Keywords: photonic crystal fiber; polarization beam splitter; extinction ratio; coupling ratio

Citation: Lou, J.; Yang, Y.; Zhang, X.; Qu, Q.; Li, S. Ultra-Short Dual-Core Photonic Crystal Fiber Polarization Beam Splitter with Round Lattice and As_2S_3-Filled Center Air Hole. *Photonics* **2022**, *9*, 36. https://doi.org/10.3390/photonics9010036

Received: 19 November 2021
Accepted: 5 January 2022
Published: 8 January 2022

Publisher's Note: MDPI stays neutral with regard to jurisdictional claims in published maps and institutional affiliations.

1. Introduction

With the development of big data analysis and cloud computing technology, traditional communication methods are far from meeting people's increasing demand for information. All-optical network communication [1–3] has the advantages of super-large capacity, super-high speed, high-quality, high-performance transmission, etc. It is an emerging technology to improve the amount of communication information. The construction of all-optical networks requires the support of high-performance optical devices [4–6]. Photonic crystal fiber (PCF) has become the first choice for preparing optical devices because of its excellent performance and low cost. Researchers have designed optical devices such as PCF sensors [7], PCF beam splitters [8] and PCF filters [9,10] according to the flexible internal structure of PCF. The inside of PCF [11–14] is composed of many periodically arranged pores. By changing the structure and layout of the pores, the symmetry can be broken, so that it has many characteristics that traditional optical fibers do not have, such as ultra-low propagation loss [15], polarization effect [16], chromatic dispersion [17], high nonlinear [18], endless single mode transmission [19], large mode area [20], ultra high or low birefringence [21], and so on.

Using the birefringence characteristics of PCF, the x and y orthogonal polarization beams can be separated within a short distance. Through this characteristic, many researchers have designed PCF polarization beam splitters. In 2014, Chen et al. [22] proposed a liquid crystal modulation core dual-core silica glass PCF polarization splitter. The separate length is 0.175 mm, and the extinction ratio is −80.7 dB at the communication wavelength of 1550 nm. In the same year, Fan et al. [23] designed a kind of dual-core gold-filled

Busta n. 5 – Informatica

- Il candidato realizzi in Excel un vettore con 20 valori e ne estragga massimo e minimo

Busta n. 3

1-Il candidato individui nel suo curriculum le esperienze che ritiene maggiormente attinenti al profilo e sulla base di queste illustri quale contributo ritiene di poter dare alle attività dell'ASI.

2-Il candidato discuta le principali tipologie di rumore proprie di un rivelatore ottico di sua scelta

3-Discussione dell'elaborato scritto, redatto dal candidato, su aspetti indicati dalla commissione.

4-Il candidato illustri i principali compiti del responsabile unico di procedimento (RUP).

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Article

Effects of Asymmetric Coupling Strength on Nonlinear Dynamics of Two Mutually Long-Delay-Coupled Semiconductor Lasers

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Abstract: This study investigates the effects of asymmetric coupling strength on nonlinear dynamics of two mutually long-delay-coupled semiconductor lasers through both experimental and numerical efforts. Dynamical maps and spectral features of dynamical states are analyzed as a function of the coupling strength and detuning frequency for a fixed coupling delay time. Symmetry in the coupling strength of the two lasers, in general, symmetrizes their dynamical behaviors and the corresponding spectral features. Slight to moderate asymmetry in the coupling strength moderately changes their dynamical behaviors from the ones when the coupling strength is symmetric, but does not break the symmetry of their dynamical behaviors and the corresponding spectral features. High asymmetry in the coupling strength not only strongly changes their dynamical behaviors from the ones when the coupling strength is symmetric, but also breaks the symmetry of their dynamical behaviors and the corresponding spectral features. Evolution of the dynamical behaviors from symmetry to asymmetry between the two lasers is identified. Experimental observations and numerical predictions agree not only qualitatively to a high extent but also quantitatively to a moderate extent.

Keywords: semiconductor lasers; nonlinear dynamics; mutual coupling; asymmetric coupling strength; symmetry breaking

Citation: Liao, B.-K.; Tseng, C.-H.; Chu, Y.-C.; Hwang, S.-K. Effects of Asymmetric Coupling Strength on Nonlinear Dynamics of Two Mutually Long-Delay-Coupled Semiconductor Lasers. *Photonics* **2022**, *9*, 28. https://doi.org/10.3390/photonics9010028

Received: 30 November 2021
Accepted: 31 December 2021
Published: 3 January 2022

1. Introduction

Nonlinear dynamics of two mutually delay-coupled semiconductor lasers has attracted much research interest due to its profound physics and promising applications. By simply adjusting the operating conditions of the two lasers, including bias current, coupling strength, and detuning frequency, various dynamical behaviors can be induced, such as mutual injection locking, period-one (P1) dynamics, period-two (P2) dynamics, quasi-periodic dynamics, and chaos. The unique temporal and spectral features found in these dynamical behaviors have been proposed, respectively, to improve performance characteristics of existing technologies, such as enhancing the bandwidth of direct modulation [1–5] and suppressing nonlinear distortion due to direct modulation [6–8], or to provide alternatives for novel applications, such as tunable microwave generation [9–12], chaotic synchronization [13–16], reservoir computing [17–19], and decision making [20]. For these technological applications, the bias currents of the two lasers are, in general, adjusted independently and differently so that specific characteristics or functionalities are achieved. This inevitably leads to a difference in the coupling strength between the two lasers, i.e., the coupling strength is asymmetric.

Prior studies [21–25] that investigate nonlinear dynamical behaviors and their features in mutually coupled lasers mainly considered symmetric coupling strength only. The dynamical behaviors of the two lasers are mainly identical, i.e., symmetric, even though

Busta n. 3 – Informatica

- Il candidato realizzi in Excel un vettore con 10 numeri casuali compresi tra 0 e 1

Busta n. 1

1- Il candidato individui nel suo curriculum le esperienze che ritiene maggiormente attinenti al profilo e sulla base di queste illustri quale contributo ritiene di poter dare alle attività dell'ASI.

2- Il candidato descriva come realizzerebbe un sistema di acquisizione per un esperimento di metrologia e/o spettroscopia e/o quantum technologies.

3- Discussione dell'elaborato scritto, redatto dal candidato, su aspetti indicati dalla commissione.

4- Con riferimento allo statuto dell'ASI, il candidato ne indichi i vertici e ne descriva i principali compiti.

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Article

2.58 kW Narrow Linewidth Fiber Laser Based on a Compact Structure with a Chirped and Tilted Fiber Bragg Grating for Raman Suppression

Xin Tian [1,2], Chenhui Gao [1,2], Chongwei Wang [1,2], Xiaofan Zhao [1,2], Meng Wang [1,2,3], Xiaoming Xi [1,2,3] and Zefeng Wang [1,2,3,*]

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2 Hunan Provincial Key Laboratory of High Energy Laser Technology, Changsha 410073, China
3 State Key Laboratory of Pulsed Power Laser Technology, Changsha 410073, China
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Abstract: We report a high power, narrow linewidth fiber laser based on oscillator one-stage power amplification configuration. A fiber oscillator with a center wavelength of 1080 nm is used as the seed, which is based on a high reflection fiber Bragg grating (FBG) and an output coupling FBG of narrow reflection bandwidth. The amplifier stage adopted counter pumping. By optimizing the seed and amplifier properties, an output laser power of 2276 W was obtained with a slope efficiency of 80.3%, a 3 dB linewidth of 0.54 nm and a signal to Raman ratio of 32 dB, however, the transverse mode instability (TMI) began to occur. For further increasing the laser power, a high-power chirped and tilted FBG (CTFBG) was inserted between the backward combiner and the output passive fiber, experimental results showed that both the threshold of Stimulated Raman scattering (SRS) and TMI increased. The maximum laser power was improved to 2576 W with a signal to Raman ratio of 42 dB, a slope efficiency of 77.1%, and a 3 dB linewidth of 0.87 nm. No TMI was observed and the beam quality factor M^2 maintained about 1.6. This work could provide a useful reference for obtaining narrow-linewidth high-power fiber lasers with high signal to Raman ratio.

Keywords: narrow linewidth; fiber lasers; Stimulated Raman scattering; chirped and tilted fiber Bragg gratings

Citation: Tian, X.; Gao, C.; Wang, C.; Zhao, X.; Wang, M.; Xi, X.; Wang, Z. 2.58 kW Narrow Linewidth Fiber Laser Based on a Compact Structure with a Chirped and Tilted Fiber Bragg Grating for Raman Suppression. *Photonics* **2021**, *8*, 532. https://doi.org/10.3390/photonics8120532

Received: 3 October 2021
Accepted: 22 November 2021
Published: 25 November 2021

1. Introduction

In the past years, owing to the great improvement of laser diodes (LDs) brightness and high-quality large mode area (LMA) fiber as well as beam combining technology, the output power of continuous-wave (CW) fiber lasers has been scaled rapidly [1–4]. However, the further improvement of single fiber output power is limited by various nonlinear effects, transverse mode instability (TMI), thermal effect, etc. For the present single fiber lasers, further power scaling is even difficult with compromise in bandwidth, beam quality, and so on. Spectral beam combining (SBC) is a promising approach to break through the limitations of the fiber lasers [5,6]. In SBC, the key is that the sub beam needs to be a narrow linewidth fiber laser (NLFL) with high beam quality, which usually realize by a main oscillator power amplifier (MOPA) configuration [7]. At present, there is no unified definition about the "narrow" of NLFLs. Considering its practical application in SBC, in this paper, the linewidth of NLFLs is defined as <1 nm. For MOPA structure, there are two main types of seeds, namely few longitudinal mode fiber oscillator laser (FOL) seed and phase modulated single-frequency laser (PMSFL) seed. The method utilizing a phase modulation seed for power amplification is relatively mature, benefiting from the stable temporal property, high nonlinear effects threshold and spectral purity during the

Busta n. 1 – Informatica

- Il candidato realizzi due slide in power point che sintetizzino la sua esperienza di ricerca

Busta n. 2

1- Il candidato individui nel suo curriculum le esperienze che ritiene maggiormente attinenti al profilo e sulla base di queste illustri quale contributo ritiene di poter dare alle attività dell'ASI.

2- Il candidato discuta le principali tipologie di rumore proprie di una sorgente laser di sua scelta.

3- Discussione dell'elaborato scritto, redatto dal candidato, su aspetti indicati dalla commissione.

4- Il candidato discuta la differenza tra corruzione e concussione

BUSTA 2 All. 1

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Article

An Optical Tweezers-Based Single-Cell Manipulation and Detection Platform for Probing Real-Time Cancer Cell Chemotaxis and Response to Tyrosine Kinase Inhibitor PD153035

Pei-Wen Peng [1,†], Jen-Chang Yang [2,3,4,†], Mamadi M.S Colley [5] and Tzu-Sen Yang [1,3,4,5,*]

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† P.-W.P. and J.-C.Y. contributed equally to this work as co-1st authors.

Abstract: We presented an approach to address cancer cell chemotaxis and response to tyrosine kinase inhibitor PD153035 at the single-cell level. We applied an optical tweezer system together with the platform at the single-cell level to manipulate an epidermal growth factor (EGF)-coated bead positioned close to the filopodia to locally stimulate HT29 cells, the human colon cancer cell line overexpressing the EGF receptor (EGFR). To address cancer cell chemotaxis, a single-cell movement model was also proposed to quantify the propagation speed at the leading and trailing edges of the cell along the chemosensing axis. This study focused on three perspectives: probing the chemosensing process mediated by EGF/EGFR signaling, investigating the mode of locomotion during the EGF-coated bead stimulation, and quantifying the effect of PD153035 on the EGF–EGFR transport pathway. The results showed that the filopodial actin filament is a sensory system for EGF detection. In addition, HT29 cells may use the filopodial actin filament to distinguish the presence or absence of the chemoattractant EGF. Furthermore, we demonstrated the high selectivity of PD153035 for EGFR and the reversibility of binding to EGFR. We anticipate that the proposed single-cell method could be applied to construct a rapid screening method for the detection and therapeutic evaluation of many types of cancer during chemotaxis.

Keywords: chemotaxis; epidermal growth factor (EGF); epidermal growth factor receptor (EGFR); tyrosine kinase inhibitor; PD153035; optical tweezers; single-cell platform

Citation: Peng, P.-W.; Yang, J.-C.; Colley, M.M.S.; Yang, T.-S. An Optical Tweezers-Based Single-Cell Manipulation and Detection Platform for Probing Real-Time Cancer Cell Chemotaxis and Response to Tyrosine Kinase Inhibitor PD153035. *Photonics* **2021**, *8*, 533. https://doi.org/10.3390/photonics8120533

Received: 18 October 2021
Accepted: 24 November 2021
Published: 26 November 2021

1. Introduction

Cancer cell chemotaxis in the surrounding microenvironment is an essential component of tumor progression and metastasis [1]. Chemotaxis has been recognized as a target for therapeutic intervention, a therapeutic endpoint, and a prognostic marker [2]. The chemotactic response of cancer cells consists of three major steps: chemosensing, polarization, and locomotion. Cancer cells respond to gradients of chemotactic factors by increasing the nucleation and polymerization of the actin filaments [3], where the polymerization of actin leads to directional migration of cancer cells in response to chemoattractant gradients. Recently, receptor tyrosine kinases such as epidermal growth factor receptor (EGFR) have been reported as signaling factors that mediate chemotactic responses in EGF/EGFR signaling [1,2]. Therefore, a rigorous understanding of the mechanism of cancer cell chemotaxis will help us develop novel concepts and strategies for cancer therapy.

Busta n. 2 – Informatica

- Il candidato realizzi in power point una slide di contenuto a piacere con delle animazioni

Busta n. 7

1- Il candidato individui nel suo curriculum le esperienze che ritiene maggiormente attinenti al profilo e sulla base di queste illustri quale contributo ritiene di poter dare alle attività dell'ASI.

2- Il candidato dopo aver scelto uno tra le seguenti sorgenti laser:
-Laser Mode Locked
-Interband Cascade Laser (ICL)
Ne descriva il funzionamento e ne contestualizzi l'impiego in un esperimento di metrologia e/o spettroscopia e/o quantum technologies.

3- Discussione dell'elaborato scritto, redatto dal candidato, su aspetti indicati dalla commissione.

4- Il candidato illustri il rapporto tra DVSS (Documento di Visione Strategica per lo Spazio) e Piano Triennale delle Attività.

Busta 7 All. 1

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Communication

Theoretical Comparison of Optothermal Absorption in Transmissive Metalenses Composed of Nanobricks and Nanoholes

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3 Joint Laboratory for Extreme Conditions Matter Properties, Southwest University of Science and Technology, Mianyang 621010, China; yizaomy@swust.edu.cn
* Correspondence: hcyu2018@sinano.ac.cn (H.Y.); yexin@caep.cn (X.Y.)

Abstract: Background: Optical components with high damage thresholds are very desirable in intense-light systems. Metalenses, being composed of phase-control nanostructures with peculiar properties, are one of the important component candidates in future optical systems. However, the optothermal mechanism in metalenses is still not investigated adequately. **Methods:** In this study, the optothermal absorption in transmissive metalenses made of silicon nanobricks and nanoholes is investigated comparatively to address this issue. **Results:** The geometrical dependencies of nanostructures' transmittance, phase difference, and field distribution are calculated numerically via simulations. To demonstrate the optothermal mechanism in metalenses, the mean absorption efficiencies of the selected unit-cells, which would constitute metalenses, are analyzed. The results show that the electric field in the silicon zone would lead to an obvious thermal effect, and the enhancement of the localized electric field also results in the strong absorption of optical energy. Then, two typical metalenses are designed based on these nanobricks and nanoholes. The optothermal simulations show that the nanobrick-based metalens can handle a power density of 0.15 W/μm^2, and the density of the nanohole-based design is 0.12 W/μm^2. **Conclusions:** The study analyzes and compares the optothermal absorption in nanobricks and nanoholes, which shows that the electric-field distribution in absorbent materials and the localized-field enhancement are the two key effects that lead to optothermal absorption. This study provides an approach to improve the anti-damage potentials of transmissive metalenses for intense-light systems.

Keywords: optothermal absorption; metasurfaces; complementary nanostructures; intense-light systems

Citation: Tang, F.; Li, Q.; Yu, H.; Yi, Z.; Ye, X. Theoretical Comparison of Optothermal Absorption in Transmissive Metalenses Composed of Nanobricks and Nanoholes. *Photonics* **2022**, *9*, 39. https://doi.org/10.3390/photonics9010039

Received: 10 November 2021
Accepted: 6 January 2022
Published: 11 January 2022

1. Introduction

Intense-light systems increasingly impact laser fabrication [1], directed energy [2], renewable energy [3,4], etc. Transmissive phase components with high damage thresholds serve the crucial roles of beam shaping, steering, and focusing in these systems. Traditional refractive components mainly rely on geometrical shapes to bend rays, leading to the high complexity of intense-light systems. Flat optical components with anti-damage properties are the core to solving this problem. Particularly, metalenses, being composed of phase-control nanostructures with peculiar properties such as ultra-compact [5,6], large field of view [7,8], perfect absorption [9–11], etc., are one of the most important candidates for the future [12–14]. Many metasurfaces have been investigated to realize phase-control functions, such as imaging [15,16], steering [17–19], and holographic imaging [20,21]. However, the optothermal mechanism in metalenses is still not investigated adequately.

Due to the electromagnetic resonant effect, the electric field is usually localized in nanostructures [12], which would lead to optothermal absorption. This phenomenon is employed to induce deformation in laser fabrication of nanostructures [22]. The experiments

Busta n. 7 – Informatica

- Il candidato realizzi in Excel un grafico a torta con dei dati di sua scelta