

Numerical Modelling of the Optical–Acoustical Characterization of an Anti-Resonant Bragg Hollow Core Fiber

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Abstract: Anti-resonant hollow core fibers (AR-HCFs) provide a promising solution for photothermal spectroscopy and photoacoustic imaging applications. Here, the AR-HCF serves as a micro platform to induce the photothermal/photoacoustic effect. Since the Bragg structure can induce multiple AR effects compared with the general AR-HCF, we proposed a novel device, the AR-BHCF (AR-HCF with Bragg cladding), to enhance the excitation efficiency. The simulation and experimental results validate that the AR-BHCF dominates in having a stronger ability to confine the optical field in the air core indeed. Then, the acoustic signal stimulated by the photoacoustic effect will propagate along with the fiber axial, and part of it will penetrate out of the AR-BHCF. The results revealed that the transmission bandwidth of the acoustic wave in the AR-BHCF ranges from 1 Hz to 1 MHz, covering infrasound to ultrasound. In particular, a constant coefficient of 0.5 exists in the acoustic wave fading process, related to the propagation frequency and time. The acoustic signal can be monitored in real time, assisted by the ultra-highly sensitive sensor head. Therefore, BHCF-based devices combined with photoacoustic techniques may accelerate their sensing applications. Meanwhile, this scheme shines a light on the theoretical foundation of novel short-hand distributed acoustic sensing.

Keywords: multiple AR effects; AR-BHCF; photoacoustic effect; acoustic wave



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1. Introduction

Hollow core fiber (HCF), as a special microstructure device, has enabled sensor size miniaturization. In recent years, the anti-resonant (AR) effect integrated into HCF has shined light on its optical characterization, which is referred to as anti-resonant hollow core fiber (AR-HCF). It is precisely because the AR effect enriches the optical transmission in the HCF, which provides a micro-sized inline platform to achieve diversified sensing detection. In particular, AR-HCF has a great prospect in special scenario sensing applications, such as in the fields of microfluidics [1], photothermal spectroscopy [2], and photoacoustic imaging [3,4]. Moreover, several common physical parameters can be directly detected by monitoring the variation in the AR transmission spectrum. For example, exploiting the drift of the resonance peak can acquire the measurement of temperature [5], displacement [6], stress [7], curvature [8], refractive index [9], and gas pressure [10]. These measurands all take advantage of the AR optical characteristics, which feature resonant peaks and an irregularly coherent envelope [11]. Unlike the direct wavelength demodulation of the aforementioned parameters, the photothermal or photoacoustic effect needs the interaction between light and gas to excite acoustic signals [12]. AR-HCF combined with femtosecond

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Proceedings of the Symposium on Optical and Acoustical Micro-Electronics, New York, N.Y., April 16-18, 1974

Jerome Fox, Mark Howard Schlam, 1975 Microlithography Bruce W. Smith, Kazuaki Suzuki, 2018-10-03 This new edition of the bestselling Microlithography Science and Technology provides a balanced treatment of theoretical and operational considerations from elementary concepts to advanced aspects of modern submicron microlithography Each chapter reflects the current research and practices from the world's leading academic and industrial laboratories detailed by a stellar panel of international experts New in the Second Edition In addition to updated information on existing material this new edition features coverage of technologies developed over the last decade since the first edition appeared including Immersion Lithography 157nm Lithography Electron Projection Lithography EPL Extreme Ultraviolet EUV Lithography Imprint Lithography Photoresists for 193nm and Immersion Lithography Scatterometry Microlithography Science and Technology Second Edition authoritatively covers the physics chemistry optics metrology tools and techniques resist processing and materials and fabrication methods involved in the latest generations of microlithography such as immersion lithography and extreme ultraviolet EUV lithography It also looks ahead to the possible future systems and technologies that will bring the next generations to fruition Loaded with illustrations equations tables and time saving references to the most current literature this book is the most comprehensive and reliable source for anyone from student to seasoned professional looking to achieve robust accurate and cost effective microlithography processes and systems **Semiconductor Devices and**

Integrated Electronics A. G. Milnes, 2012-12-06 For some time there has been a need for a semiconductor device book that carries diode and transistor theory beyond an introductory level and yet has space to touch on a wider range of semiconductor device principles and applications Such topics are covered in specialized monographs numbering many hundreds but the voluminous nature of this literature limits access for students This book is the outcome of attempts to develop a broad course on devices and integrated electronics for university students at about senior year level The educational prerequisites are an introductory course in semiconductor junction and transistor concepts and a course on analog and digital circuits that has introduced the concepts of rectification amplification oscillators modulation and logic and SWitching circuits The book should also be of value to professional engineers and physicists because of both the information included and the detailed guide to the literature given by the references The aim has been to bring some measure of order into the subject area examined and to provide a basic structure from which teachers may develop themes that are of most interest to students and themselves Semiconductor devices and integrated circuits are reviewed and fundamental factors that control power levels frequency speed size and cost are discussed The text also briefly mentions how devices are used and presents circuits and comments on representative applications Thus the book seeks a balance between the extremes of device physics and circuit design **Handbook of VLSI Microlithography** John N. Helbert, 2001-04-01 This handbook gives readers a

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submicron range has now been made possible by the introduction of innovative circuit designs and the development of new microelectronic materials and processes This book addresses the latter challenge by assessing the current status of the science and technology associated with the production of VLSI silicon circuits It represents the cumulative effort of experts from academia and industry who have come together to blend their expertise into a tutorial overview and cohesive update of this rapidly expanding field A balance of fundamental and applied contributions cover the basics of microelectronics materials and process engineering Subjects in materials science include silicon silicides resists dielectrics and interconnect metallization Subjects in process engineering include crystal growth epitaxy oxidation thin film deposition fine line lithography dry etching ion implantation and diffusion Other related topics such as process simulation defects phenomena and diagnostic techniques are also included This book is the result of a NATO sponsored Advanced Study Institute AS held in Castelvecchio Pascoli Italy Invited speakers at this institute provided manuscripts which were edited updated and integrated with other contributions solicited from non participants to this AS

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Acoustoelectric Interactions in Acoustic Surface Wave Devices Stanford University. Microwave Laboratory,1976

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Table of Contents Optical Acoustical Microelectronics

1. Understanding the eBook Optical Acoustical Microelectronics
 - The Rise of Digital Reading Optical Acoustical Microelectronics
 - Advantages of eBooks Over Traditional Books
2. Identifying Optical Acoustical Microelectronics
 - Exploring Different Genres
 - Considering Fiction vs. Non-Fiction
 - Determining Your Reading Goals
3. Choosing the Right eBook Platform
 - Popular eBook Platforms
 - Features to Look for in an Optical Acoustical Microelectronics
 - User-Friendly Interface
4. Exploring eBook Recommendations from Optical Acoustical Microelectronics
 - Personalized Recommendations
 - Optical Acoustical Microelectronics User Reviews and Ratings
 - Optical Acoustical Microelectronics and Bestseller Lists
5. Accessing Optical Acoustical Microelectronics Free and Paid eBooks
 - Optical Acoustical Microelectronics Public Domain eBooks
 - Optical Acoustical Microelectronics eBook Subscription Services
 - Optical Acoustical Microelectronics Budget-Friendly Options
6. Navigating Optical Acoustical Microelectronics eBook Formats

- ePub, PDF, MOBI, and More
- Optical Acoustical Microelectronics Compatibility with Devices
- Optical Acoustical Microelectronics Enhanced eBook Features
- 7. Enhancing Your Reading Experience
 - Adjustable Fonts and Text Sizes of Optical Acoustical Microelectronics
 - Highlighting and Note-Taking Optical Acoustical Microelectronics
 - Interactive Elements Optical Acoustical Microelectronics
- 8. Staying Engaged with Optical Acoustical Microelectronics
 - Joining Online Reading Communities
 - Participating in Virtual Book Clubs
 - Following Authors and Publishers Optical Acoustical Microelectronics
- 9. Balancing eBooks and Physical Books Optical Acoustical Microelectronics
 - Benefits of a Digital Library
 - Creating a Diverse Reading Collection Optical Acoustical Microelectronics
- 10. Overcoming Reading Challenges
 - Dealing with Digital Eye Strain
 - Minimizing Distractions
 - Managing Screen Time
- 11. Cultivating a Reading Routine Optical Acoustical Microelectronics
 - Setting Reading Goals Optical Acoustical Microelectronics
 - Carving Out Dedicated Reading Time
- 12. Sourcing Reliable Information of Optical Acoustical Microelectronics
 - Fact-Checking eBook Content of Optical Acoustical Microelectronics
 - Distinguishing Credible Sources
- 13. Promoting Lifelong Learning
 - Utilizing eBooks for Skill Development
 - Exploring Educational eBooks
- 14. Embracing eBook Trends
 - Integration of Multimedia Elements
 - Interactive and Gamified eBooks

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