

# Dual dynamically tunable terahertz graphene-based plasmonic induced transparency and slow light effects

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## Abstract

A novel single-layer graphene-based structure is designed in this article. This structure consists of two graphene strips and two graphene blocks. The components of this structure generate two bright modes and one dark mode in the terahertz region, and these three modes undergo destructive interference, leading to the phenomenon of double plasmonic induced transparency. The graphene of this structure has continuity, and the Fermi level can be adjusted by adjusting the bias voltage applied to the structure. Compared with those discontinuous structures, it is easier to achieve tuning function. The structure uses the finite-difference time-domain for data simulation, uses the coupled mode theory for theoretic calculation, and compares the transmission spectra obtained by the two methods. Through observation, it can be found that the frequency positions of the peaks and dips of the simulated transmission spectrum increase with the increase of the Fermi level, showing a perfect linear relationship, which indicates that this structure has great prospects in the modulator. In addition, the structure has achieved good results in the slow light effect, and after measurement, the peak values of group index and group delay can reach up to 380 and 0.241 ps, respectively. By utilizing these advantages, this structure can provide more possibilities for the development and research of slow light fields.

**Keywords:** plasmonics, metamaterials, integrated optics devices

## 1. Introduction

In recent years, with the increasing attention and understanding of researchers on metamaterial, graphene has entered the vision of researchers [1–4]. Graphene has the advantages of high electrical conductivity, long lifetime plasmon excitation, low loss, and easy modulation [5, 6], thus is widely used in optics [7–10], materials science [11–13], micro/nano processing [14, 15], energy [16] and other fields. With the

deepening of research, scientists have found that single-layer graphene exhibits similar properties to metals in the terahertz band, and can successfully excite surface plasmons polaritons. Graphene-based metasurfaces can also achieve plasmonic induced transparency (PIT) phenomena. The traditional electromagnetic induced transparency (EIT) [17] effect is a typical quantum coherent effect, which essentially prevents atoms at the atomic level from participating in the coupling of light under the action of the coupling field, thereby gradually reducing the absorption of weak probe light by the medium and even making it completely transparent. And PIT is a phenomenon similar to EIT that occurs at the resonant frequency

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# Slow Transparency

**Cecily Rose**



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Slow Light Jacob B. Khurgin, Rodney S. Tucker, 2018-10-08 One of the Top Selling Physics Books according to YBP Library Services The exotic effects of slow light have been widely observed in the laboratory However current literature fails to explore the wider field of slow light in photonic structures and optical fibers Reflecting recent research Slow Light Science and Applications presents a comprehensive introduction to slow light and its potential applications including storage switching DOD applications and nonlinear optics The book covers fundamentals of slow light in various media including atomic media semiconductors fibers and photonic structures Leading authorities in such diverse fields as atomic vapor spectroscopy fiber amplifiers and integrated optics provide an interdisciplinary perspective They uncover potential applications in both linear and nonlinear optics While it is impossible to account for all the captivating developments that have occurred in the last few years this book provides an exceptional survey of the current state of the slow light field

New Horizon of Plasmonics and Metamaterials Masafumi Kimata, Shinpei Ogawa, 2020-06-25 Plasmonics and metamaterials are growing fields that consistently produce new technologies for controlling electromagnetic waves Many important advances in both fundamental knowledge and practical applications have been achieved in conjunction with a wide range of materials structures and wavelengths from the ultraviolet to the microwave regions of the spectrum In addition to this remarkable progress across many different fields much of this research shares many of the same underlying principles and therefore significant synergy is expected This Special Issue introduces the recent advances in plasmonics and metamaterials and discusses various applications while addressing a wide range of topics in order to explore the new horizons emerging for such research

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distinguished history and reaffirm its commitment to poetry with publication of *The Wesleyan Tradition* Drawing from some 250 volumes editor Michael Collier documents the wide ranging impact of these works In his introduction he describes the literary and cultural context of American poetics in more recent decades tracing the evolution of the Deep Image and Confessional movements of the 50s and 60s and exploring the emergence of the prose lyric style Although the success of the Wesleyan program has inspired its share of imitators no other program has had such a fundamental impact Works by the eighty six poets included her both document and celebrate that contribution     *The Photographic Journal of America ...*,1888     *The Encyclopaedia Britannica* ,1902     *Living in the Comfort Zone* Rokelle Lerner,2010-04-12 Here is one of the most useful books on relationships you will ever read This book challenges you to explore the unknown depths of the soul and claim your individuality while learning to connect with others in a healthy way The term comfort zone describes the internal sanctuary you create by developing and maintaining your boundaries Only through conscious creation of your comfort zone can you develop the ability to be present in body mind and spirit in order to create healthy relationships Only by defining yourself can you connect with others Rokelle Lerner addresses the practical issues of maintaining both your separateness and your sacred domain of connection she explains how you can walk a spiritual path with practical feet Lerner has filled this book with her clients personal stories modeling potential problems that can arise in relationships due to unformed or violated boundaries You will learn how to stop boundary intruders and boundary distancers mend the body and soul deal with shame heal emotional intellectual and spiritual boundaries set limits unlock bonding patterns and sustain your comfort zones while you do the soul work required for further personal growth

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