The 3rd

KU Photonics Workshop

2021. 02. 16.

KOREA UNIVERSITY 1905 KU Photonics

Ⅰ. 목 적

제 3회 KU Photonics Workshop에서는 포토닉스 분야 전문가들에 의한 초청 강연을 통하여 연구원들 간의 기술교류 및 연구내용을 공유하고 시너지 효과를 창출함으로써 융합연구를 촉진하고자 함

Ⅱ. 일시 / 장소

일 시 : 2021. 02. 16. (화) 14:00

장 소 : Online Workshop (ZOOM Meeting)

Meeting ID	812 1062 0314	QR CODE	2021.02.16.
Passcode	HVkM.A9KFt		
Direct Link	https://korea-ac-kr.zoom.us/j/81210620314?pwd=enF6UDBlQ1pNckVKeVhQK0FQblRXZz09		

Ⅲ. 강 연

- 연 사
  - 장무석 교수, 카이스트 바이오및뇌공학과

    'Solving' and 'using' optical complexity:

    seeing through biological tissues and unlocking optical space through designed complex nanostructures
  - 박연상 교수, 충남대학교 물리학과

    Metasurface-integrated light emitting devices
  - 장민석 교수, 카이스트 전기및전자공학부

    Real-space imaging of acoustic plasmons in graphene
  - 이한석 교수, 카이스트 물리학과

    Frequency comb generation on a chip:

    recent progress toward practical applications
  - 김영덕 교수, 경희대학교 물리학과

    Deep ultraviolet light emission from atomically thin hexagonal boron nitride van der Waals heterostructures

Date			Program	Presenter (Chair)
2월 16일 (화)	14:00 ~ 14:10	(10)	Opening remark	
	장무석 교수 (카이스트 바이오및뇌공학과) 초청강연			
	14:10 ~ 14:40	(30)	강연 및 Q&A	장무석 교수 (김명기 교수)
			'Solving' and 'using' optical complexity: seeing through biological tissues and unlocking optical space through designed complex nanostructures	
	박연상 교수 (충남대학교 물리학과) 초청강연			
	14:40 ~ 15:10	(30)	강연 및 Q&A	박연상 교수 (김명기 교수)
			Metasurface-integrated light emitting devices	
	장민석 교수 (카이스트 전기및전자공학부) 초청강연			
	15:10 ~ 15:40	(30)	강연 및 Q&A	장민석 교수 (김명기 교수)
			Real-space imaging of acoustic plasmons in graphene	
	15:40 ~ 16:00	(20)	Break	
	이한석 교수 (카이스트 물리학과) 초청강연			
	16:00 ~ 16:30	(30)	강연 및 Q&A	이한석 교수 (박규환 교수)
			Frequency comb generation on a chip: recent progress toward practical applications	
	김영덕 교수 (경희대학교 물리학과) 초청강연			
	16:30 ~ 17:00	(30)	강연 및 Q&A	김영덕 교수 (박규환 교수)
			Deep ultraviolet light emission from atomically thin hexagonal boron nitride van der Waals heterostructures	
	17:00		Closing	

'Solving' and 'using' optical complexity: seeing through biological tissues and unlocking optical space through designed complex nanostructures

장무석 (Mooseok Jang)

카이스트 바이오및뇌공학과 (Bio and Brain Engineering, KAIST)

2021.02.16. Tuesday 14:10 ~ 14:40

Abstract :

This talk will explore ways to solve and use optical complexity. In the first part of the talk, I will introduce the approaches to solve the optical complexity in biological tissues and present the proof-of-concept of seeing through biological tissues. One approach is to retrace multiple light scattering in a 'time-reversed' fashion using optical phase conjugation and the other is to reject the multiply scattered light for a better visibility of ballistic light. I will focus on our recent development in the development of spatiotemporal gating scheme to optimally reject the multiply scattered light. In the second portion, I will present a novel way of using designed complex nanostructures to unlock an optical space that is inaccessible using conventional optics. Furthermore, I will briefly talk about our recent development in using a deep neural network for image reconstruction in a lensless imaging scheme.

Metasurface-integrated light emitting devices

박연상 (Yeonsang Park)

충남대학교 물리학과 (Department of Physics, Chungnam Nationcal University)

2021.02.16. Tuesday 14:40 ~ 15:10

Abstract :

Since the first emergence of metasurfaces to manipulate light at the subwavelength scale, the planarization of existing optical elements has been demonstrated successfully and various applications using metasurfaces such as metalens, meta-hologram, meta-polarization convert etc have been developed by many research groups. Even though successful realization of planar optical components within thin film with several hundred nanometers by metasurfaces, the application of metasurfaces to light emitting devices such as lasers was a little reported until nowadays. Here, I will present light emitting devices integrated with plasmonic and dielectric metasurfaces. The one is a colloidal quantum dot (CQD) light emitting diodes with metasurface-patterned electrode, and the other is a CQD resonant cavity integrated with dielectric deflector made of two TiO_2 nanoposts. By integrating metasurfaces on light emitting devices, I could control the direction of CQD emission from the devices at will. To prove the directional emission by metasurfaces, photoluminescence spectra and momentum-space far-field images of light emitted via metasurfaces were measured. From the measured data, I could make sure of deflection ability of our metasurfaces clearly. Especially, the deflection efficiency by dielectric metasurfaces could be obtained as about 71 % at the wavelength of 600 nm. Due to the lack of sufficient 2π phase shift of our metasurfaces, the directed emission did not show the directivity with a well-defined k-vector as the case of the metalens, and is slightly diffused. Nevertheless, as refining the etching technology of TiO_2 materials, I expect that the full phase change of TiO_2 nanoposts can be possible and therefore, metasurface-integrated light emitting devices with accurate direction vector can be fabricated soon. This integration of metasurfaces with light emitting devices may help to develop next-generation light emitting devices with novel functions.

Real-space imaging of acoustic plasmons in graphene

장민석 (Jang, Min Seok)

카이스트 전기및전자공학부 (School of Electrical Engineering, KAIST)

2021.02.16. Tuesday 15:10 ~ 15:40

Abstract :

An acoustic graphene plasmon (AGP) supported by a heterostructure comprising of a metal, a thin dielectric spacer, and a graphene layer is mostly confined in the dielectric and does not exhibit a cutoff when spacer thickness reduces to a ~1 nm scale. Therefore, AGP provides an unexcelled mode volume confinement factor up to ~1010, outperforming all known polaritonic modes in 2D materials. Confinement in dielectric spacer also allows for the far-field coupling efficiency as high as 100% in an AGP resonator with optical cavity. So far, AGP probing has been demonstrated either in the far-field regime in mid-IR, or via the near-field-mediated photocurrent measurements at THz frequencies. In this presentation, we report on the first near-field optical imaging of AGP, employing a scattering-type scanning near-field optical microscope (s-SNOM) in the mid-IR. We directly measure the AGP dispersion and propagation loss, and investigate its behavior in a periodic structure. Most importantly, our results reveal a small damping rate of infrared AGP even when unprotected large-area CVD graphene is used at ambient conditions. The probed AGP mode is up to 2.3 times more compressed, yet exhibits a 1.4 times lower damping rate than the graphene surface plasmon under similar conditions. In addition, we demonstrate near-field images and analyze properties of a resonant AGP Bloch state in a 1D array of gold nanoribbons, which is responsible for the reported earlier high coupling efficiency in far-field regime.

Frequency comb generation on a chip: recent progress toward practical applications

이한석 (Hansuek Lee)
카이스트 물리학과 (Department of Physics, KAIST)

2021.02.16. Tuesday 16:00 ~ 16:30

Abstract :

Frequency combs, which are irreplaceable light sources in various scientific fields requiring extreme precision such as timekeeping, spectroscopy, and metrology, have been miniaturized on a chip by means of ultra-high-Q resonators, Kerr nonlinearity, and soliton mode-locking technique. Despite recent remarkable progress, the complex scheme required for entering the soliton state remains a major obstacle, which severely limits its real-world application due to increased system complexity and integration difficulty. In this talk, I introduce our recent work which demonstrates and analyzes a simple soliton generation scheme consisting of a free-running pump laser and a microcavity without any external circuits for feedback control. In this work, a continuous-wave pump detuned in the thermally-stable blue side of a resonance generates a Brillouin lasing signal which relays the pump power to the soliton pulses via intracavity mode-coupling without breaking thermal self-stability. I also discuss the practical noise performance of microcomb with showing our recent measurement of 2.5-fs RMS timing jitter over 0.1-ms for the comb of 22 GHz repetition rate. In addition, our on-going efforts to generate this chip-scale frequency combs in the mid-IR for molecular fingerprint will be introduced.

Deep ultraviolet light emission from atomically thin hexagonal boron nitride van der Waals heterostructures

김영덕 (Young Duck Kim)

경희대학교 물리학과 (Department of Physics, Kyung Hee University)

2021.02.16. Tuesday 16:30 ~ 17:00

Abstract :

Two-dimensional (2D) van der Waals materials and their heterostructures, such as graphene, and transition metal dichalcogenides (TMDC) emerge as key materials for the next-generation nanoscale optoelectronics for lighting, next-generation display modules, and quantum information processing. To date, however, limited color emission spectrum (< 2 eV) and lack of efficient up-conversion strategy in van der Waals materials are key challenges for developments of practical 2D material-based optoelectronics in the visible range.

Color centers in solids are responsible for the unique optical properties and developments of nanoscale optoelectronic devices in the broadband spectrum. Especially, natural and artificial color centers in wide bandgap semiconductors are considered the key architectures for ultraviolet (UV) nanophotonics, bio-sensing, high precision metrology, and single photon source. Thus, creation and manipulation of color centers in wide bandgap van der Waals materials such as hexagonal boron nitride (hBN) are very important for UV-visible optoelectronics developments. Here, I will present the deep UV (220~390nm) electroluminescence (EL) and broadband photodetection from hBN heterostructures. Broad UV EL in hBN are attributed to the electric field induced artificial color centers, which are vacancy-related defects with an excitonic mode in the intrinsic band gap of hBN (> 6.4 eV). These results demonstrate the promise of hBN-based van der Waals heterostructures for light sources and optoelectronics in the UV to the visible regime.