PKU-UTokyo Joint Research Center of Excellence for Nanocarbons

2019 PKU-UTokyo Nanocarbon Summer Camp

Place: Hongo Campus, The University of Tokyo

Time: August 1st - 7th, 2019

2019 PKU-UTokyo Nanocarbon Summer

General information

This year's Summer Camp will bring together 35 participants, including 13 (3 faculty members and 10 graduate students) from PKU, and 15 (5 faculty members + 10 students) from UTokyo. For a week time, participants will intensively discuss recent progress in Nano-carbon research, and propose potential collaborations between PKU and UTokyo.

On 2nd, we will hold a one focused workshop where Leading researchers in Japan will give tutorial lectures on their recent results related to nano-carbon research. After this, there will be a tour to some UTokyo Labs. All participants are suggested to attend.

From 3rd, student participants will be divided into 5 teams for independent work and discussion. Each team will propose a potential collaborative research direction between PKU and UTokyo. To help everybody know each other, a self-introduction session will be held in the morning of 3rd, and all students give a 5 min presentation including brief introduction of themselves and their research.

After intensive work and discussion, students give their final report and presentation on 6th.

The official language of summer camp is English.

Notes:

Participants from PKU ***must*** give your boarding pass to our staff at the registration. Please send a scanned copy of the boarding pass for your return flight.

The dress code for the Camp is casual; you do not need any formal clothing.

Summers in Tokyo are fairly hot and humid, expecting temperature is 25-35°C, and it may rain.

Contacts:

Email: maruyama@photon.t.u-tokyo.ac.jp (Prof. Shigeo Maruyama)
xiangrong@photon.t.u-tokyo.ac.jp (Assistant Prof. Rong Xiang)

TEL: <Mon.-Fri. worktime> Maruyama office: +81-3-5841- 6421

Facilitators:

Ahmed Shawky: ahmed@photon.t.u-tokyo.ac.jp
Ming Liu (柳铭): liuming@photon.t.u-tokyo.ac.jp
Seungju Seo (徐 昇柱): seo@photon.t.u-tokyo.ac.jp

Agenda for 2019 PKU-UTokyo Nanocarbon Summer Camp

Students | Professor | Both

	8 am	9	10	11	12	1 pm	2	3	4	5	6	7	8	9
Aug. 1 (Thur.)								Arrival at Narita, JL860 (Zeyao, Yongjia) Hotel check in [2] access to Super APA Hotel Ueno			Registration [3] access to UTokyo @ 2-232 (3F) (Terao)			
Aug. 2 (Fri.)		Registration	Workshop [1] program @ 2-31A (Ahmed)		Group photo & Lunch		Workshop @ 2-31A (Ahmed, Maruyama)	Lab tour for students [7] (Ahmed, Seo)		Break	Banquet @ Restaurant ABREUVOIR [4] place information (Terao)			
Aug. 3 (Sat.)		Student presentation [5, 6] (Liu) @ 232 / Professor meeting (if needed)			Lunch and discussion		Group working @ 232 (Liu) [8] Internet information / Professor meeting (if needed)				Break	Group working @ 232 (If needed)		
Aug. 4 (Sun.)		Tour to Ueno Park, (Seo, Zheng) / Professor meeting (if needed)			Lunch and discussion		Group working @ 232 (Zeyao) / Professor meeting (if needed)				Break	Group working @ 232 (If needed)		
Aug. 5 (Mon.)		Group working @ 232 / Professor meeting (if needed)			Lunch and discussion		Group working @ 232 (Henan) / Professor meeting (if needed)				Break	Group working @ 232 (If needed)		
Aug. 6 (Tues.)			Final presentation [9] @ 2-31A (Maruyama, Li, Xiang, Zeyao)		Lunch, discussion, refreshment			Summary and Awards @ 2-31A (Xiang)						
Aug. 7 (Wed.)								Departure to Beijing, JL869 (Yongjia, Seo, Henan)						

1. Workshop program

2019 PKU-UTokyo NanoCarbon Workshop

Time: **Aug 2nd** (Fri.), 2019, 9:30-14:45

Place: Room **31A** (3rd floor), Eng. Bld. 2, Hongo Campus, The University of Tokyo

Co-organizer: Shigeo Maruyama and Yan Li

Chair: Ahmed Shawky

9:30 - 9:50	Registration
9:50 -10:00	**Yan Li**
	Opening
10:00 -11:00	**Kosuke Nagashio** (UTokyo)
	2D layered semiconductors
11:00 -11:05	Group Photo
11:05 -12:05	**Kazu Suenaga (**AIST**)**
	Advanced Transmission Electron Microscopy
12:00 -13:30	Lunch
13:30 -14:00	**Tatsuya Tsukuda** (UTokyo)
	Au Clusters
	Lab tour within UTokyo
14:00 - 15:00	Tsukuda-Lab.
15:00 - 16:00	Ikuhara Lab.
16:00 – 17:00	Maruyama Lab.
18:00 -	**Banquet**

2. Hotel for students

Hotel information:
https://www.apahotel.com/hotel/shutoken/44_keiseiueno-ekimae/

Hotel name:	アパホテル〈京成上野駅前〉
	APA Hotel Keiseiueno-Ekimae
Address:	〒110-0005 東京都台東区上野 2-14-26
Contact:	03-5846-6811
Check-in date:	2019-8-1 (Thur.)
Check-out date:	2019-8-7 (Wed.)

About check in:

You will need to pay the hotel fee when you check in, so please first leave your luggage at front desk (already confirmed with hotel) and come to University of Tokyo for registration (and cash!!!). After dismiss, go back to hotel, check in and pay.

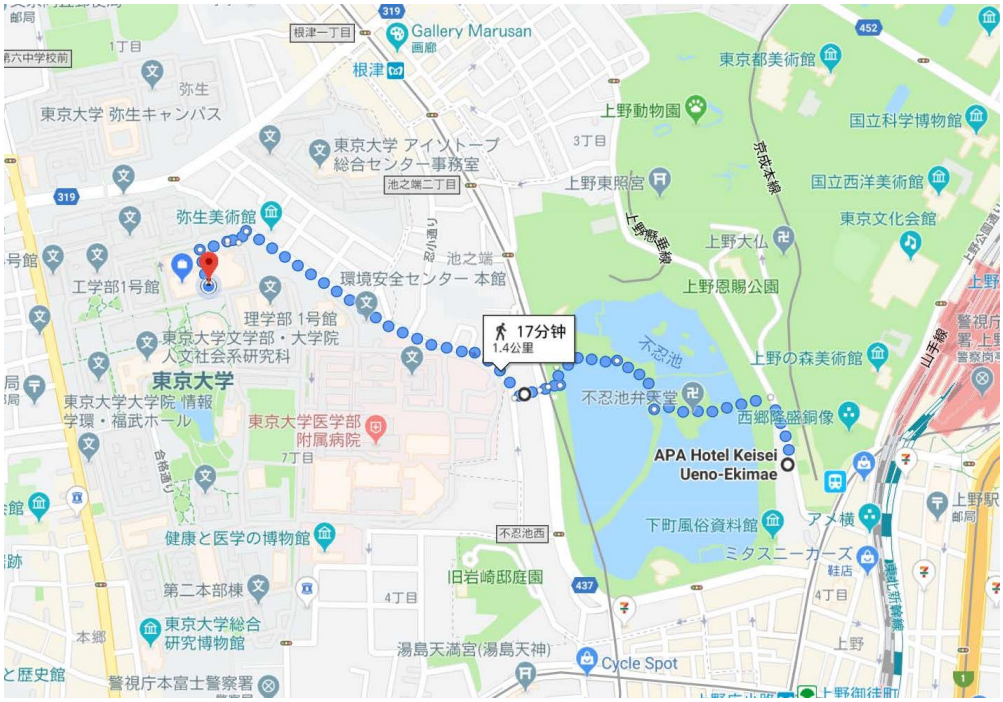
List of guest:

1: JIA GUODONG
2: ZHAO XUE
3: YAN WENQING
4: FANG LI
5: SUN PENGKUN
6: HONG HAO
7: ZHAO YAN
8: WANG KUN
9: LI YANGLIZHI
10: GAO RUI

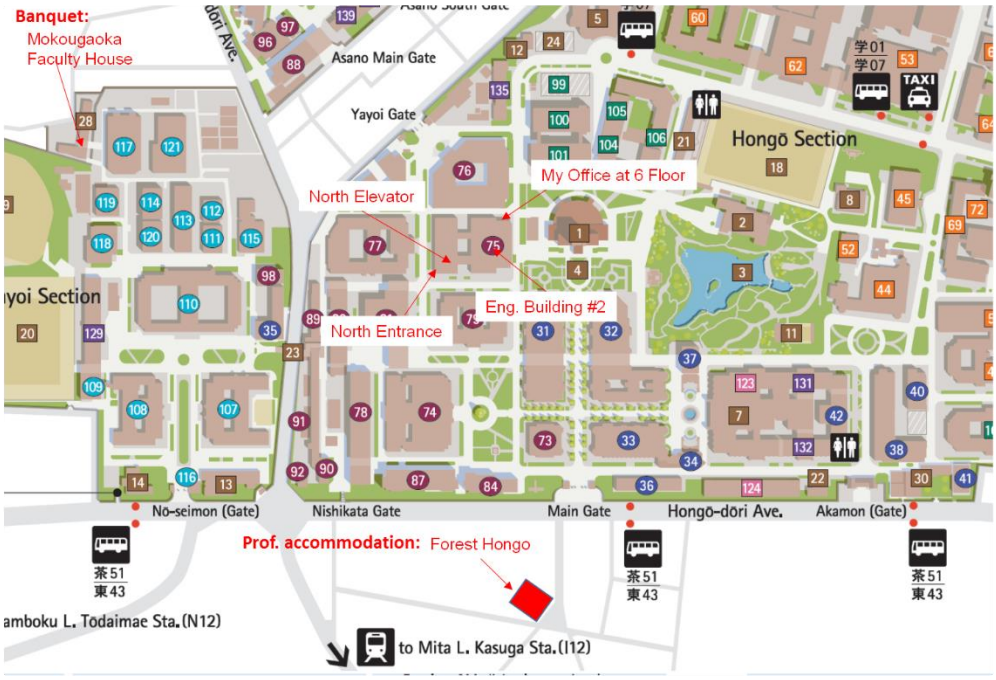
11: ZHANG ZEYAO

3. Access to UTokyo, Engineering Building #2

It is about 20 min walk from hotel to UTokyo. It is a good experience to go across or along Ueno-Park.



Maruyama Chiashi Lab. in Engineering Building 2, Office room number 63C2
Registration at 3rd floor, room number 2-31A



4. Banquet information

Everybody (both faculties and students) from Japan and China side is invited to banquet.

Banquet:
Aug. 2nd, 18:00-21:00
Restaurant ABREUVOIR
The University of Tokyo, Yayoi Campus,
1-1-1 Yayoi, Bunkyo-ku, Tokyo 113-0032 Japan
TEL 03-5805-2505 FAX 03-5805-2565
http://www.u-tokyo.ac.jp/campusmap/cam01_00_30_j.html

!!Important!!
Due to fund regulation in Japan, unfortunately, all participants must share the cost for the drinks (Food is covered).
We will collect money at registration or entrance of the Banquet
Students: 1000 yen
Others: 2000 yen

5. Students presentation

All the student participants from both China and Japan side will be asked to give a 5 min presentation including your self-introduction and research direction (morning of 3rd). You are advised to come a bit earlier to test the functioning of your ppt file.

6. Grouping

You are suggested to form 5 team x 4 people. Please make teams freely, but each team is suggested to have 2 PKU students and 2 UTokyo students. A team with all Chinese is not allowed. Furthermore, each team should have at least one female student.

7. Lab tours

14:00-15:00 Ttsukuda Lab. @ Department of Chemistry
http://www.chem.s.u-tokyo.ac.jp/users/chemreact/index-e.html

15:00-16:00 Crystal Interface (Ikuhara) Lab. @ Institute of Engineering Innovation
http://interface.t.u-tokyo.ac.jp/japanese/index.html

16:00-17:00 Maruyama-Chiashi Lab. @ Department of Mechanical Engineering
http://www.photon.t.u-tokyo.ac.jp/

8. Internet

All participants from PKU side will be provided by a guest account at registration for wifi access in Utokyo. However, since the password change automatically every week, we will re-announce the new one on Monday. You are also encouraged to bring your wifi, or make eduroam account.

Participants from UT side please use your own wifi access (Utokyo-wifi, istmember, etc.) and please do NOT share your Utokyo account with our visitors (due to the recent network attack to Utokyo known in newspapers, Utokyo is now very sensitive to the security issue). However, you may help your teammates to download the journal papers.

9. Final presentation

- ✓ Each team proposes a potential collaborative project between PKU and Utokyo
- ✓ Topic should be related but not limited to Nano-carbon research
- ✓ Each team gives a 20 min presentation on their proposal. (15 min talk + 5 min Q&A)
- ✓ All members of a team need to present, and the contributions of each member need to be clarified at beginning of the presentation.
- ✓ Each team needs to submit one page summary (format not limited), as well as their presentation PowerPoint for final score.

10. Participant list

Name	Kanji	Affiliation	Supervisor	e-mail
Shigeo Maruyama	丸山 茂夫	The University of Tokyo		maruyama@photon.t.u-okyo.ac.jp
Yan Li	李 彦	Peking University		yanli@pku.edu.cn
Kazu Suenaga	末永 和知	AIST		suenaga-kazu@aist.go.jp
Tatsuya Tsukuda	佃 達哉	The University of Tokyo		tsukuda@chem.s.u-tokyo.ac.jp
Kosuke Nagashio	長汐 晃輔	The University of Tokyo		nagashio@material.t.u-tokyo.ac.jp
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Ming Liu	柳 铭	The University of Tokyo		liuming@photon.t.u-tokyo.ac.jp
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Kun Wang	王坤	Peking University	Zhongfan Liu	wangkun-cnc@pku.edu.cn
Yanglizhi Li	李杨立志	Peking University	Zhongfan Liu	liylz-cnc@pku.edu.cn
Rui Gao	高锐	Peking University	Liangbing Gan	1801110277@pku.edu.cn
Yongjia Zheng	鄭永嘉	The University of Tokyo	Shigeo Maruyama	zhengyj@photon.t.u-tokyo.ac.jp
Bunsho Koyano	小矢野 文	The University of Tokyo	Shohei Chiashi	koyano@photon.t.u-tokyo.ac.jp
Taikou Murakami	村上 大巧	The University of Tokyo	Shigeo Maruyama	murakami-t@photon.t.u-tokyo.ac.jp
Henan Li	李 賀楠	The University of Tokyo	Shigeo Maruyama	lihenan@photon.t.u-tokyo.ac.jp
Daiki Okazaki	岡崎大樹	The University of Tokyo	Satoshi Ashihara	dokazaki@iis.u-tokyo.ac.jp
Zheyuan Zhang	張 哲元	The University of Tokyo	Set Sze Yun	zhang@cntp.t.u-tokyo.ac.jp
Takumi Matsuda	松田 拓	The University of Tokyo	Fumihiko Kannari	taku.1218@keio.jp
Shuhei Okawa	大川脩平	The University of Tokyo	Shigeo Maruyama	okawa@photon.t.u-tokyo.ac.jp
Seungju Seo	徐 昇柱	The University of Tokyo	Shigeo Maruyama	seungju1991@gmail.com
Jiye Han	韓智叡	Pusan National University	J. Oh, IL Jeon	hanyksw20@naver.com

Abstract

Chemical vapor deposition of one-dimensional heterostructures

Yongjia Zheng[1], Rong Xiang[1], Taiki Inoue[1], Shigeo Maruyama[1,2]

[1] Department of Mechanical Engineering, The University of Tokyo, Tokyo 113-8656, Japan

[2] Energy Nano Engineering Lab., National Institute of Advanced Industrial Science and Technology (AIST), Tsukuba. 305-8564, Japan

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Graphene/h-BN interfaces have generated great interests recently due to the possibility of combining diverse atomic layers to create novel materials and devices. In this work, we demonstrate a new one-dimensional van der Waals heterostructures (vdWH) nanotube structure with similar heterostructure interfaces that combines the single-walled carbon nanotubes (SWCNTs), boron nitride nanotubes (BNNTs) and molybdenum disulfide nanotubes (MSNTs) in the radial direction. Ammonia borane (BH_3NH_3) as precursor was directly used to synthesize BNNTs with the aid of SWCNTs as a template by a facile chemical vapor deposition (CVD) technique. Absorption spectra and Raman spectra confirmed not only the formation of BNNTs from BH_3NH_3, but also the undamaged condition of SWNTs. Furthermore, scanning electron microscopy (SEM) and transmission electron microscopy (TEM) were employed to examine the morphology and quality of the coaxial structure. With 60 min BH_3NH_3 growth, the number of walls increased to 3-5 with the diameter of ~5 nm wide. We believe this structure will have a broad interest and impact in many fields, which include but not limited in investigating the intrinsic optical properties of environment-isolated SWCNTs, fabricating BN-protected or gated SWCNT devices and building more sophisticated 1D material systems. It can also be used for photovoltaics and light-emitting devices when combining transition metal dichalcogenide monolayers (TMDC) materials.

Self-introduction

I received my Bachelor's Degree in Materials Physics at South China Normal University (SCNU) in 2014. With my excellent academic performance and research experience, I was officially recommended by SCNU for admission to Sun Yat-sen University, where I pursued my Master Degree in Optical Engineering in 2014-2017. At present, I am pursuing Doctoral degree in Mechanical Engineering from The University of Tokyo and working in preparation and application of 1 dimensional SWCNT@BNNT.

Regrowth and catalytic etching of individual single-walled carbon nanotubes studied by isotope labeling and growth interruption

Bunsho Koyano[1], Taiki Inoue[1], Shun Yamamoto[1], Keigo Otsuka[2, 3], Rong Xiang[1], Shohei Chiashi[1], and Shigeo Maruyama[1, 4]

[1] Department of Mechanical Engineering, The University of Tokyo,

[2] Quantum Optoelectronics Research Team, RIKEN Center for Advanced Photonic,

[3] Nanoscale Quantum Photonics Laboratory, RIKEN Cluster for Pioneering Research,

[4]Energy NanoEngineering Laboratory, National Institute of Advanced Industrial Science and Technology (AIST)

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To realize the efficient growth of single-walled carbon nanotubes (SWCNTs), the growth mechanism behind catalyst activity and growth rates needs to be elucidated at the single nanotube level. In this study, we synthesized SWCNTs with growth interruption, where only Ar, Ar/H2, or Ar/H2/H2O was introduced during a pause in the supply of a carbon source, in order to examine the effects of additive molecules in a chemical vapor deposition process. This interrupted growth was performed in combination with an isotope labeling technique to show the time evolution of individual SWCNT growth. While the introduction of Ar during the growth interruption tended to terminate SWCNT growth, the introduction of Ar/H2 resulted in the regrowth of SWCNTs once ethanol was reintroduced. When interrupted with Ar/H2/H2O, SWCNTs were etched catalytically while sliding themselves in the reverse direction of growth and, then, regrew. Raman analysis revealed that the chirality of SWCNTs was preserved even after etching and regrowth. The growth rates of SWCNTs were unchanged before and after the interruption in the case of Ar/H2, but they were increased by a factor of ~1.7 in the case of Ar/H2/H2O. These results provide effective means to maintain the catalyst activity and to enhance growth rates.

Self-introduction

I am Bunsho Koyano, a second year master's student. I was born in Osaka. I like to watch American comedy dramas. My favorite one is Silicon Valley. I also like to listen to music. Nice to meet you.

Synthesis of Hetero Multi-Walled Nanotubes

Taikou Murakami[1], Hayato Arai[1], Yongjia Zheng[1] , Yang Qian[1], Taiki Inoue[1], Rong Xiang[1], Shohei Chiashi[1], Shigeo Maruyama[1,2]

[1] Dept. of Mech. Eng., The Univ. of Tokyo, [2] Energy NanoEngeering Lab., AIST

murakami-t@photon.t.u-tokyo.ac.jp

Single-Walled Carbon Nanotube (SWCNT) is promising material for electronics due to its high carrier mobility and smallness of diameter. Boron Nitride (BN) and Molybdenum Disulfide (MoS_2) are 2D materials. The former is insulator and the latter semiconductor. Recently, Many researchers make 2D heterostructure to control physical property of 2D materials. At our laboratory, Xiang synthesized 1D heterostructure of MoS_2/BN/SWCNT (Fig. 1a)[1], but it could not be applied to device due to its bundle. My research topic is to synthesize BN layer and MoS_2 layer on isolated SWCNT for device application.

I used Chemical Vapor Deposition (CVD) method to synthesize each layer. SEM image (Fig. 1b) shows that there is suspended tube structure at substrate. Raman mapping image (Fig. 1c,d) show that there is MoS_2 on SWCNT.

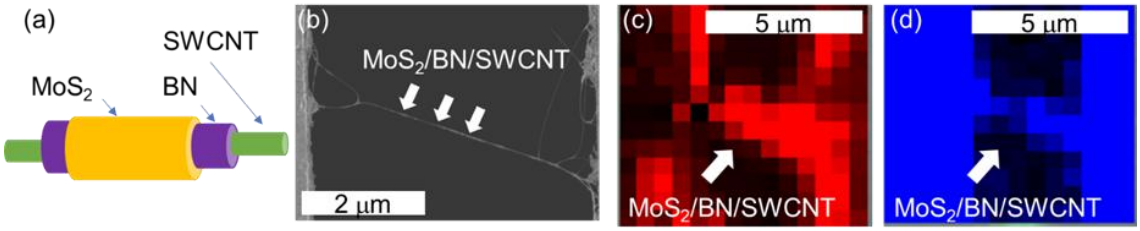

Fig.1 (a) Schematic image of MoS_2/BN/SWCNT. (b) SEM image of suspended MoS_2/BN/SWCNT. (c, d) Raman mapping images of MoS_2/BN/SWCNT based on the intensity of (c) G band (SWCNT) and (d) A_{1g} band (MoS_2).

[1] R. Xiang *et al.*, arXiv :1807.06154.

Self-introduction

Name : Taikou Murakami

Age : 23 (Second year of a Master's degree)

Hometown : Gifu (200 km west from Tokyo)

Hobby : Watching movie and drama (at Amazon Prime).

Characterization of BN coated zeolite SWCNTs

Henan Li , Ya Feng, Bo Hou, Shigeo Maruyama

Department of Mechanical Engineering, School of Engineering, University of Tokyo

lihenan@photon.t.u-tokyo.ac.jp

We performed a series of optical characterization (absorption, Raman and PL) of single-walled carbon nanotubes (SWCNTs) grown on zeolite-supported Co-Fe catalyst and boron nitride (BN) coated SWCNTs. We directly grew the BN coating outside the SWCNTs without dispersion of zeolite and SWCNTs. As there is large number of bundles and disordered SWCNTs across the zeolite, it is difficult to prove that there is BN coating directly by TEM. But according to the comparison of optical characterization results of SWCNTs and BN-coated SWNCTs, there is significant difference between Raman and photoluminescence (PL) spectrum (Figure 2). Also, the difference between the performance after annealing in air for the same time (Figure 1, 3) have proved that the BN coating protects the SWCNTs inside to some extent during annealing period.

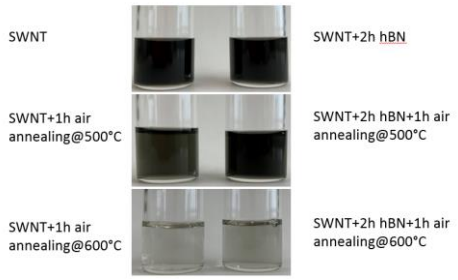

Figure 1

CNT solution after dispersion

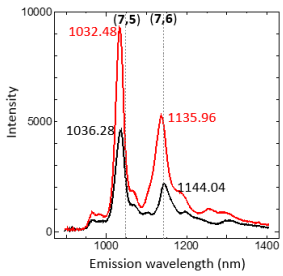

Figure 2

PL spectrum before annealing (Black: SWCNTs; Red: BN coated SWCNTs)

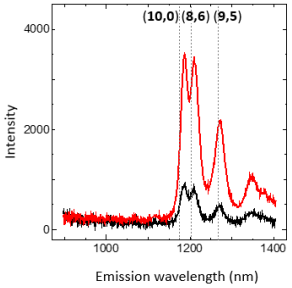

Figure 3

PL spectrum after annealing (Black: SWCNTs; Red: BN coated SWCNTs)

Self-introduction

Name: Henan Li

Age:23

Hometown: Hangzhou, China

Interests: Sports (Especially Basketball)

Concerts

Animation & PC games

Development of SWCNT mode-locked Cr:ZnS laser

Daiki Okazaki[1], Satoshi Ashihara[1]

[1]The Institute of Industrial Science, The University of Tokyo

dokazaki@iis.u-tokyo.ac.jp

Ultrashort pulses in the mid-infrared region have a great potential in the applications of advanced vibrational spectroscopy and strong field phenomena. Cr:ZnS is an attractive candidate for mid-IR ultrafast lasers mainly because of its broad fluorescence spectrum centered at 2.4 μm

Single walled carbon nanotubes (SWCNTs) are well-known as ideal saturable absorbers in the near infrared region. Their nonlinear absorption property has been enabled us to realize ultrashort pulse lasers whose temporal pulse durations are less than hundreds of femtoseconds. However, they have rarely been applied to mid-infrared ultrafast lasers because typical nanotubes (d_t = 1.3~1.6 nm) show an inverse saturable absorption above the wavelength of 2 μm.

Here, we achieve Cr:ZnS mode-locking by using a SWCNT film[1] that has a diameter around 2.2 nm and a resonant saturable absorption at the wavelength of 2.4 μm resulting from E_{11}^S transition (Figure 1). Figure 2 shows the obtained spectrum whose FWHM is 9.2 THz which corresponds to the 49 fs of the temporal duration.

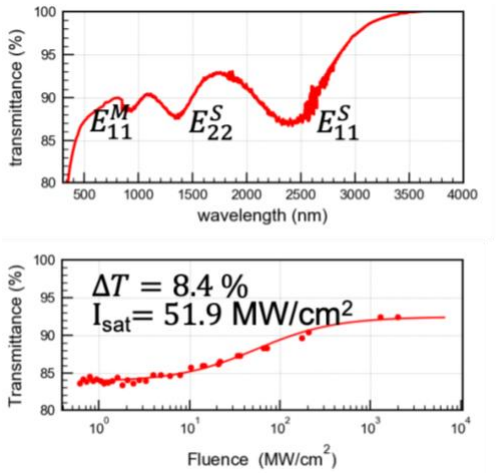

Fig. 1 Linear and nonlinear transmittance of SWCNTs.

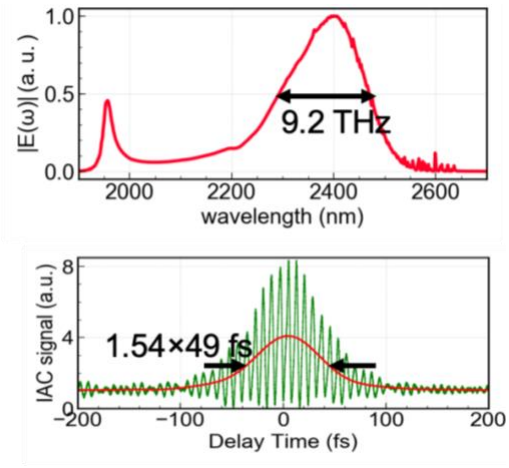

Fig. 2 Laser spectrum and autocorrelation

Reference [1] D. Okazaki *et al., Opt. Lett.* **44**, 7, 1750-1753 (2019)

Self-introduction

Name: Daiki Okazaki

Age: 24

Hometown: Hiroshima, Japan

Interests: Ultrafast lasers, Nonlinear optics

Hobby: Juggling

Comment: I'm not particular about carbon nanomaterials, so I wonder that I want to study a lot in this summer camp.

Multiple-wavelength Q-switched Fiber Laser Using Synthetic Single-crystal Diamond Saturable Absorber

Zheyuan Zhang[1], Yuanjun Zhu[1], Pengtao Yuan[1], Hongbo Jiang[1], Zihao Zhao[1], Fulin Xiang[1], Lei Jin[1], Sze Yun Set[1], Shinji Yamashita[1]

[1] Research Center for Advanced Science and Technology, The University of Tokyo, 4-6-1, Komaba, Megro-ku,Tokyo 153-8904, Japan

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Optical pulsed lasers offer a broad range of applications in various fields including optical communications, optical signal processing, two-photon microscopy, laser surgery etc. A saturable absorber in a lasing cavity can favor short pulse generation and suppress continuous wave radiation. In this research, the saturable absorber properties of synthetic single-crystal diamond is demonstrated. According to experimental result, β of type Ib diamond at 1550 nm is calculated to be -3.6×10^{-13} m/W, which is opposite to reported value at visible spectrum ($\beta = 9\times10^{-12}$ m/W @ 427.5 nm). On the other hand, n_2 of diamond is 4×10^{-18} m^2/W at 1550 nm, having a relatively better agreement to the value of 8×10^{-20} m^2/W at 427.5 nm.

Compare to other commonly used SA, Synthetic diamonds have extremely high thermal damage threshold as well as stable physical and chemical properties. So it provides the possibility for achieving extremely high power Laser Pulse Generation. A Q-switched fiber laser using synthetic diamond as saturable absorber (SA) which performs multi-wavelength-like output is also proposed and demonstrated. The wave length ranges from 1553-1561 nm with a spectrum spacing of 0.48 nm. The pulse-width of output pulse train varies from 7 μs to 4.9 μs and the corresponding repetition rate changes from 17.1 kHz to 56.2 kHz with pump powers between 84.8 to 754.3 mW. By tuning the loss in cavity, we can also achieve a dual-main-peak spectrum.

Self-introduction

I came from Qingdao and this is my second year in Tokyo as doctoral student. I got my bachelor and master degree at Beijing Institute of Technology and my major was optical-electrics. My research topics include free-space optics, fiber laser, laser sensing and nonlinear optics. I have strong interests in programing, art and sociology. I am glad to have a chance to make more friends with same hobbies.

Ultrafast nano spectroscopy with nano taper tip

Takumi Matsuda[1], Fumihiko Kannari[2]

[1] Keio University, [2]Department of Electronics and Electrical Engineering

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The focused spot of light has a diffraction limit and can only be reduced to about half the wavelength. Therefore, the optical device is large and the resolution of lithography is low. As long as propagating light is used, the physical size of the optical device cannot be smaller than the diffraction limit.It is known that nanofocusing beyond the diffraction limit can be achieved by wave number matching the light to metal nano taper tip, coupling it and propagating it to the tip. My theme is ultrafast nanospectroscopic measurement that combines femtosecond laser pulses with nanofocusing. In our laboratory, nano pump-probe CARS measurement and lithography to graphene oxide have already been realized.

At present, we are thinking about whether it will be possible to operate near-field optical microscopes that operate under unusual conditions such as soft or wet samples.

Self-introduction

Name:Takumi Matsuda

Year: 22 (M1)

Home town: Chiba, Japan

I’m glad to work with you. I’ll do my best.

Improvement of Perovskite Solar Cells Using SWNTs

Shuhei Okawa[1], Il Jeon[1], Shigeo Maruyama[1,2]

[1] *Department of Mechanical Engineering, The University of Tokyo, Tokyo 113-8656, Japan,*

[2] *Energy Nano Engineering Laboratory, National Institute of Advanced Industrial Science and Technology (AIST), Ibaraki 305-8564, Japan*

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Single-walled carbon nanotubes (SWNTs) possess excellent electrical conductivity and optical transparency, qualifying them for an alternative to transparent conductors in optoelectronic devices. SWNTs have been frequently used as an anode (hole-conductor) in perovskite solar cells (PSCs) since SWNTs are naturally a p-type conductor in air. On the other hand, due to the low power conversion efficiency (PCE) arising from the challenging nature of its energy alignment, SWNT cathode has not been explored extensively. Previously, Jeon et al. reported a PCE of 10.5 % from an inverted-type PSC in which a SWNT cathode drenched in $PC_{61}BM$ was used as the top electrode. In our research, we explored different materials to $PC_{61}BM$ to improve the SWNT cathode properties in PSCs from the optoelectronic perspective. After a through interface engineering of SWNTs cathodes, we achieved a PCE of 11.1 % with SWNT film top electrode-based PSCs (Fig. 1) by incorporating polyaromatic anthracene ammonium (AA, Fig. 2) molecules which clenched onto SWNTs film to enhance its charge selectivity.

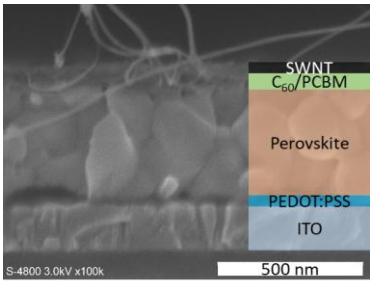


Fig. 1 Cross section of PSCs.

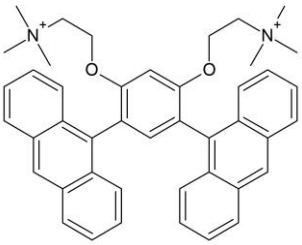
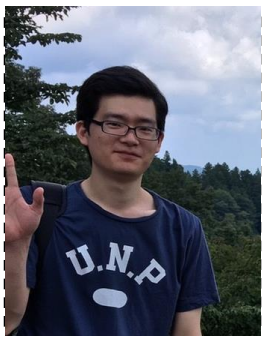


Fig. 2 Molecular structure of AA.

Self-introduction



My name is Shuhei Okawa. I was born in 1995 in Nagasaki ,Japan. Now I am in my second year of the master course and studying the perovskite solar cells and carbon nanotubes.

I like watching TV such as variety shows and sometimes go to see a comedy show live.

Semiconducting carbon nanotubes as crystal growth templates and grain bridges in perovskite solar cells

Seungju Seo[1], Il Jeon[1], Yutaka Matsuo[1,2], Shigeo Maruyama[1,3]

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[2] Institute of Innovation for Future Society, Nagoya University, Furo-cho, Chikusa-ku, Nagoya 464-8603, Japan

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Grain size control and boundary passivation of perovskite films are the key to obtaining efficient perovskite solar cells. In order to accomplish both goals, semiconducting single-walled carbon nanotubes are added to perovskite films as additives, functioning as both the crystal growth templates and charge bridges between the perovskite grains. The resulting perovskite films display more uniform and larger crystal grains compared with conventional films owing to the long and flexible single-walled carbon nanotubes, retarding the crystal growth and functioning as the cross-linker between perovskite grains. In addition, sodium deoxycholates attached on the carbon nanotubes passivated the grain boundaries by forming Lewis adducts. Thanks to the improved quality of the photoactive layers by using semiconducting carbon nanotubes, a power conversion efficiency of 19.5% was obtained which is higher than 18.1% of reference devices with no additives.

Self-introduction

Hello. I am Seungju Seo, pursuing mechanical engineering Ph.D. under supervision of Prof. Shigeo Maruyama at the University of Tokyo. I am from South Korea and have been in Japan for 9 years. I will be happy to discuss anything related to research for future collaborations. Thank you!

Metallization based on M13 Bacteriophage

Jiye Han[1,2], Il Jeon[2], Jinwoo Oh[1]

[1] Department of Nano Fusion Technology, Pusan National University, Busan, 46241, Republic of Korea,

[2] Department of Mechanical Engineering, The University of Tokyo, 7-3-1 Hongo, Bunkyo-ku, Tokyo 113 8656, Japan

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In recent years, study of nano-scale manufacturing technology using nanomaterials was significantly attracted by many researchers. And there is a lot of discussion about the stability of nanomaterials. In this study, we used M13 bacteriophage, which is a nano-scale bio-material and is proven to be stable for humans.

M13 bacteriophage is a helical structured biomaterial with 6.6nm of the diameter and 880nm of the length. And M13 bacteriophage has a threadlike shape, with about 2,800 peptides exposed to the surface. The peptide has a variety of amino acid groups and is charged according to the exposed amino acids. In this work, we fabricated nanowires by reducing metal on the surface of M13 bacteriophage. We observed that metal reduced along the surface of the M13 bacteriophage.

Self-introduction

Hello. I am Jiye Han, My department is Nano Fusion Technology at the Pusan national University in Korea. Now, I am doing an internship at Tokyo University. I'm glad to be able to participate in this camp. Thank you!

Graphene/carbon nanotube hybrid aerogel with graphitizing connection

Guodong Jia, Yan Li

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jiagd@pku.edu.cn

Hierarchical 3D architectures assembled by graphene and carbon nanotubes show promising application in actuator, shape memory, oil cleaning, etc. However, their mechanical and electronic properties still have many problems to be resolved. One of the major problems is poorly connection between individual nanocarbon components.

Here, we treat graphene/carbon nanotube hybrid aerogel with a thermal process, the metal nanoparticles forming in this process catalyzed growing graphite carbon at connected position, which will greatly enhance the mechanical and electronic properties.

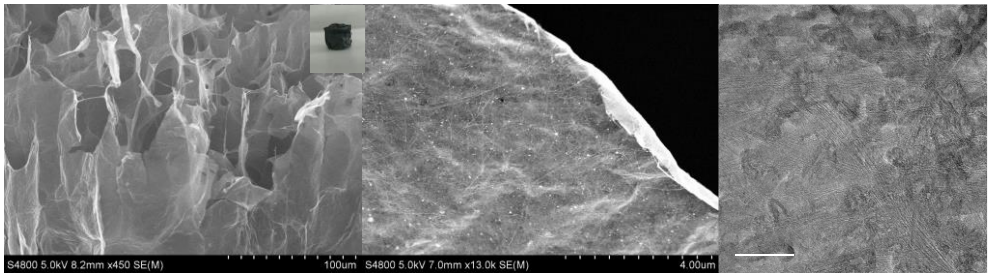

Figure a-b) graphene/carbon nanotube hybrid aerogel at different scale, insert of a) is optical image of the hybrid aerogel c) TEM image of graphite connection at interface.

Self-introduction

Give My name is Guodong Jia, I'm from Shanxi province, China. After studying for four years at Tongji University, I got my bachelor degree. Now I'm studying at Professor Yan Li' group, Peking University. In my spare time, I'd like to go to movies, reading novels, etc. I'm glad to be friends of every one of you.

Wafer-scale synthesis of single-walled carbon nanotubes on the silicon substrate

Xue Zhao[1], Qidong Liu[1], Yan Li[1]

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The growth of carbon nanotubes (CNTs) on arbitrary wafer-size substrates is highly desirable for large-scale integrated sensors and nanoelectronics. In order to achieve the wafer-scale synthesis of SWNTs, we built a low-pressure CVD(LPCVD) system and attempted to verify the possibility of uniformly growing CNTs. We succeeded in growing CNT thin films with single-metal catalysts such as Fe, Co, Ni under suitable LPCVD growth conditions. The as-grown CNT thin films had high densities and good quality, and the thin films can be loaded with gold particles to be used for surface-enhanced Raman spectroscopy (SERS). Subsequently, Co_7W_6, which remains its solid crystalline structure at a high temperature of 700-1100℃, was used to catalyze the selective growth of enriched (12,6) SWNTs with appropriate partial pressure and ratio of ethanol and H_2. More efforts will be made towards the large-scale chirality-specific growth of SWNTs.

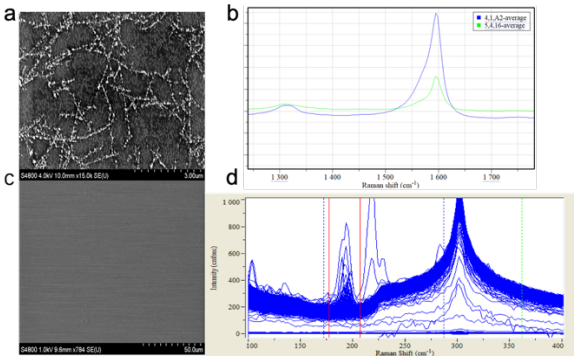


Figure (a-b) SEM image and Raman spectra of CNT thin films loaded with gold nanoparticles; (c-d) SEM image and Raman spectra of as-grown SWNTs catalyzed by Co_7W_6

Self-introduction

I am Zhao Xue, a 23 years old student of Yan Li's group, who has just finished her first year as a PhD candidate. I received my B.S. from Beijing Normal University in 2018. I came from the northeast of China, which makes me an optimistic and easy-going girl. I like watching movies and travelling. I am a big fan of marvel movies.

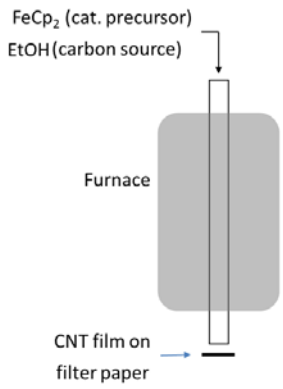
Controlled synthesis and performance studies of carbon nanotube films

Wenqing Yan[1], Zeyao Zhang[2], Yan Li[*]

[1]Academy for Advanced Interdisciplinary Studies, Peking University, [2]College of Chemistry and Molecular Engineering, Peking University

1801111497@pku.edu.cn

Transparent conducting films (TCFs) are a critical component in many personal electronic devices. Transparent and conductive doped metal oxides are widely used in industry. However, they are not compatible with future flexible electronics developments. Recent studies have shown that carbon nanotubes provide unique chemical, physical, and optoelectronic properties, making them an important alternative to doped metal oxides. My work focuses on preparation of carbon nanotube films for the applications of transparent conductive films.



The dry floating catalyst chemical vapor deposition (FCCVD) method is a direct and simple method to prepare carbon nanotube films. Ethanol can grow high quality single-walled carbon nanotube films in a wide temperature window. The gas flow rate, hydrogen ratio, and catalyst concentration during the growth process significantly affect the performance of the carbon nanotube film. By adjusting these factors, I try to prepare carbon nanotube films with high transparency and good electrical conductivity.

Self-introduction

My name is Wenqing Yan. I'm in my first year of PhD program in the Academy for Advanced Interdisciplinary Studies at Peking University. My advisor is Yan Li who directs me in the field of controlled synthesis and performance studies of carbon nanotube films. I'm at the age of 23 and I comes from Shuozhou in Shanxi Province of China. I finished my undergraduate study in the field of Material Chemistry in Nankai University in 2018.

Negative Capacitance Carbon Nanotube FETs

Li Fang[1], Chenguang Qiu[1], Zhiyong Zhang[1], Lian-mao Peng[1]

[1]Key Laboratory for the Physics and Chemistry of Nanodevices and Department of Electronics, Peking University, Beijing 100871, China

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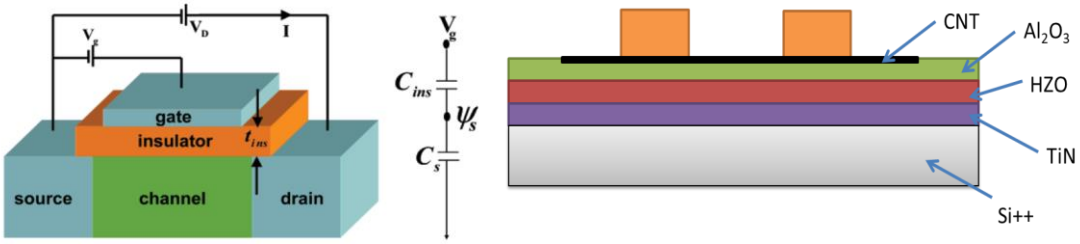
The scaling of MOSFETs has been impeded over the past decade because of the inability to scale the operating voltage. It is partly due to the sub-threshold slope (SS) limit of 60 mV/decade (at temperature = 300 K) in conventional FETs, which is also called Boltzmann tyranny. By incorporating a ferroelectric capacitance into the transistor gate stack, it serves as a negative capacitor so that the channel surface potential can be amplified more than the gate voltage, and hence the device can operate with SS less than 60mV/decade at room temperature. Meanwhile single-wall carbon nanotubes (SWCNTs) have been considered as a highly potential channel material owing to their nanoscale dimensions, high carrier mobility, and excellent stability. Hence we combine these two advantages and fabricate steep slope transistor based on carbon nanotubes with a ferroelectric hafnium zirconium oxide layer in the gate dielectric stack. The devices are expected to show a boost in the drive current and sub-60 mV/decade switching. With the amorphous Al_2O_3 layer applied for capacitance matching, hysteresis-free behavior can be observed.



Self-introduction

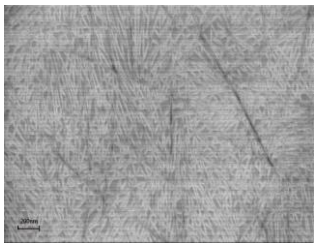
I am Li Fang, a 23-year-old girl from Jingzhou, Hubei Province. I obtained my Bachelor degree from Beijing Institute of Technology in 2017 and have been a PhD student in Deapartment of Electronics at Peking University for almost two years. My resarch mainly focuses on high peformance electronic devices based on carbon nanotubes. In my spare time, I like travelling, reading and playing sports with my friends.

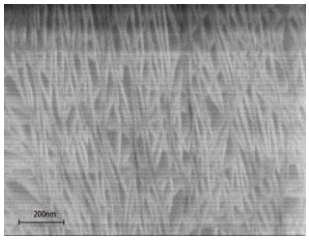
Preparation of array with high semiconducting purity carbon nanotubes and application in CMOS devices

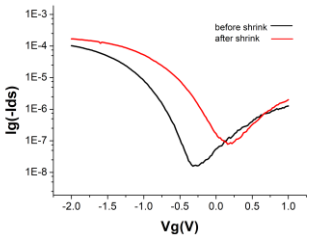
Pengkun Sun[1]

Key Laboratory for the Physics and Chemistry of Nanodevices and Department of Electronics, Peking University, Beijing 100871,China

p.k.sun@pku.edu.cn







Carbon nanotube is a kind of ideal material to construct high performance and high velocity field-effect transistor with excellent semiconductor characteristic. The main challenge for application of solution-derived carbon nanotubes (CNTs) in high performance field-effect transistor (FET) locates at how to align CNTs into an array with high density and full surface coverage. We plan to transform randomly orientated CNT network film to aligned array. Shrink to obtain CNT aligned array by directional shrinking transfer method. We find the density of carbon nanotubes after shrink become 2.5 times greater than before by SEM. Meanwhile, the on current of transistor with CNT aligned array is bigger than that of random film.

Self-introduction

My name is Pengkun Sun, 24 years old. I come from Innner Mongolia, China. I graduated from the Nanjing University with B.S. degree in Material Physics in 2018. Now I major in Physical Electronics, specifically, the Carbon nanotube Electronics. I like running and reading in spare time and wish to make friends in Tokyo University.

Ultrafast Broadband Charge Collection from Clean Graphene/$CH_3NH_3PbI_3$ Interface

Hao Hong[1], Jincan Zhang[2], Jin Zhang[3], Sheng Meng[3]*, Hailin Peng[2]*, Kaihui Liu[1]*

[1] School of Physics, Peking University, Beijing 100871, China, [2] College of Chemistry and Molecular Engineering, Peking University, Beijing 100871, China [3] Institute of Physics, Chinese Academy of Sciences, Beijing 100190, China

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Photocarrier generation in a material, transportation to the material surface, and collection at the electrode interface are of paramount importance in any optoelectronic and photovoltaic device. In the last collection process, ideal performance comprises ultrafast charge collection to enhance current conversion efficiency and broadband collection to enhance energy conversion efficiency. Here, we demonstrate ultrafast broadband charge collection achieved simultaneously at the clean graphene/organic-inorganic halide perovskite interface. The tunable two-color pump-probe spectroscopy, time-resolved photoluminescence spectroscopy and time-dependent density functional theory all reveal that the clean-interfacial graphene collects band-edge photocarriers of perovskite in an ultrashort time of ~100 fs, with a current collection efficiency close to 99%. In addition, graphene can extract deep-band hot carriers of perovskite within only ~50 fs, several orders faster than hot carrier relaxation and cooling in perovskite itself, due to the unique Dirac linear band structure of graphene, indicating a potential high energy conversion efficiency exceeding Shockley−Queisser limit. Adding other graphene superiority of good transparency, high carrier mobility and extreme flexibility, clean-interfacial graphene provides an ideal charge collection layer and electrode candidate for future optoelectronic and photovoltaic applications in two dimensions.

Self-introduction

I am 26-year-old and 5th year graduate student pursuing Ph.D. in Physics. My hometown is at Zaozhuang, Shandong Province, a beautiful city with lots of mountains. I love music, movie, and especially the Japanese manga. My research interest is nonlinear optics and ultrafast optical spectroscopy of low-dimensional materials.

The Anomalous Helicity-selection Rule in Resonance Raman Scattering for WS_2

Yan Zhao[1], Shishu Zhang[2], Lianming Tong[2*], Jin Zhang[2*]

[1] Academy for Advanced Interdisciplinary Studies, Peking University, Beijing 100871, P. R. China

[2] College of Chemistry and Molecular Engineering, Peking University, Beijing 100871, P. R. China

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When excited by circularly polarized light, the Raman scattering light may have the same or opposite helicity as the incident light. It has been reported that the E^1_{2g} mode is helicity-exchanged and A_{1g} mode is helicity-retained for TMDCs. Here we report that under off-resonance excitation, the helicity of E^1_{2g} mode for WS_2 is exchanged corresponding to the Raman selection rule. However, when excited resonantly, the helicity of E^1_{2g} mode is not fully exchanged and the selection rule is broken down. We attribute this phenomenon to the variation of the components of electron wave functions corresponding to the photon-electron interaction under on-resonance condition. We further explore the effect of temperature on helicity exchange rate of E^1_{2g} mode under on-resonance condition. With the decrease of temperature, the helicity exchange rate also decreases. This behavior may originate from the effect of temperature on the electronic band structure and the components of electron wave functions.

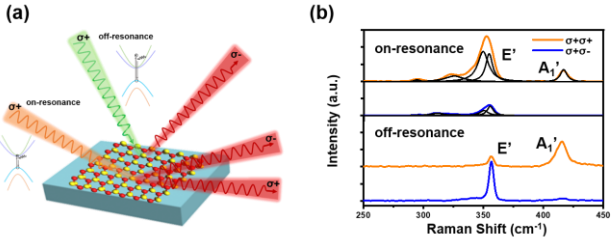

Figure 1. The schematic diagram (a) and Raman spectrum (b) of helicity-selected Raman scattering process for monolayer WS_2 under on-resonance and off-resonance excitation.

Self-introduction

Yan Zhao, 24 years old, now a PHD student of Peking University. I aim to explore the optical properties of low dimensional materials by means of optical spectroscopy, and my present research topic is the circularly polarized Raman spectroscopy of 2D materials.

Direct CVD Growth of Graphene on optical fibers

Kun Wang[1], Ke Chen[1], Kaihui Liu[2*], Zhongfan Liu[1*]

[1] Centre for Nanochemistry, College of Chemistry and Molecular Engineering, Peking University, Beijing 100871, China, [2] State Key Laboratory for Mesoscopic Physics, School of Physics, Peking University, Beijing 100871, China

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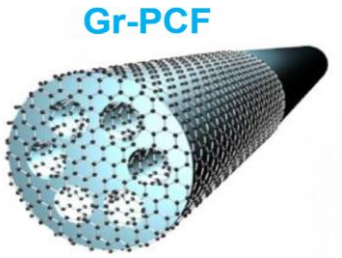
Graphene is the most broadly discussed and studied two-dimensional material because of its preeminent physical, mechanical, optical, and thermal properties. Until now, metal-catalyzed chemical vapor deposition (CVD) has been widely employed for the scalable production of high-quality graphene. However, in order to incorporate the graphene into electronic devices, a transfer process from metal substrates to targeted substrates is inevitable. This process usually results in contamination, wrinkling, and breakage of graphene samples, which is undesirable in graphene-based technology and not compatible with industrial production. Therefore, direct growth of graphene on desired insulating substrates is considered as an effective alternative.

We develop a new material of graphene photonic crystal fibre (Gr-PCF) by chemical vapour deposition method. Such Gr-PCF material exhibits a strong and tunable light-matter interaction, and presents great performance as a highly efficient electro-optic modulation in all-fibre optical system.



Self-introduction

Hi, I'm Kun Wang from Shandong province, China and I'm 23 years old. I received my B.S. in chemistry from Xiamen University in 2018, while currently pursuing Ph.D. at the College of Chemistry and Molecular Engineering, Peking University, under the guidance of Prof. Zhongfan Liu and Prof. Kaihui Liu. My research interests are graphene growth on insulating substrate and its application in optical devices.

Cleaning Graphene Surface via Carbon Nanowalls

Yanglizhi Li[1,2], Luzhao Sun[1,2], Hailin Peng[1,3*], Zhongfan Liu[1,3*]

[1] Center for Nanochemistry, Beijing Science and Engineering Center for Nanocarbons, Beijing National Laboratory for Molecular Sciences, College of Chemistry and Molecular Engineering, Peking University, Beijing 100871, P. R. China, [2] Academy for Advanced Interdisciplinary Studies, Peking University, Beijing 100871, P. R. China, [3] Beijing Graphene Institute, Beijing 100095, P. R. China

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Surface contaminants is ubiquitous on chemical vapor deposition (CVD)-derived graphene, which seriously degrades its properties and hinders its industrial application[1]. So far, many attempts have been made to solve this problem by eliminating the transfer-related polymer residues. However, large-area atomic clean graphene surface is still hard to be achieved. Herein, we put forward an effective surface-cleaning approach by removing the intrinsic contaminants, i.e., amorphous carbon originating from CVD process. In this case, superior cleanliness of graphene (over 90%) is achieved by using carbon nanowalls (CNWs) due to its huge specific surface area and strong adhesion with amorphous carbon. The successful removal of intrinsic contamination significantly suppresses the transfer-related polymer residues. Our work provides a new perspective for obtaining clean graphene interface.

Reference

1. Zhang, Z. *et al.* Rosin-enabled ultraclean and damage-free transfer of graphene for large-area flexible organic light-emitting diodes. *Nat. Commun.* **8**, 14560 (2017).

Self-introduction

My name is Yanglizhi Li (李杨立志). I am 23 years old, born in Jining, Shandong province, which is the Hometown of Confucius and Mencius. After obtaining bachelor's degree in chemistry from Lanzhou university, I came into Peking University for further study. My research focuses on the scalable production of high quality graphene films. I like playing chess and watching comedy and suspense movies in my spare time.

Nanochannels constructed from Open-cage Fullerenes

Rui Gao, Liangbing Gan*

College of Chemistry and Molecular Engineering, Peking University, Beijing, China

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Selective cleavage of multiple carbon-carbon bonds around a local area on the surface of fullerene cages can produce many different open-cage fullerenes.[1] Nowadays it is well known that both hydrogen bonding and aromatic stacking interactions are useful in crystal design for compounds with controlled physical properties.[2] In the present work, we prepared a open-cage fullerene with both imine and hydroxyl groups on the rim of the orifice, which can form a crystal structure with small molecular size nanochannels.. Crystal structure of the compound was obtained as shown below (**Figure 1**).

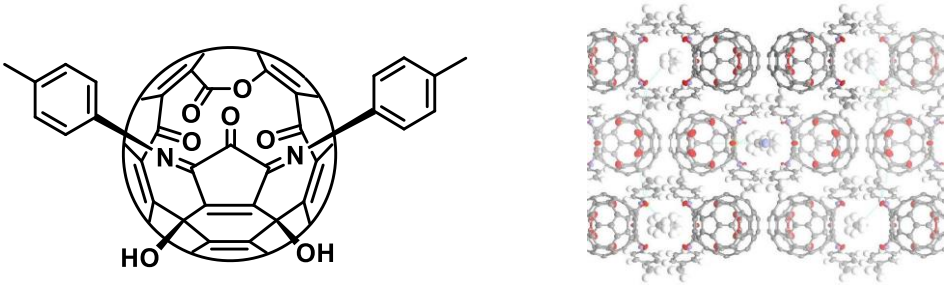

Figure 1 Structure of the open-cage fullerene molecule and the nanochannels it forms..

Reference:

1. For Reviews on open-cage fullerenes: (a) M. Murata, Y. Murata, K. Komatsu, *Chem. Commun*. **2008**, 6083; (b) G. C. Vougioukalakis, M. M. Roubelakis, M. Orfanopoulos, *Chem. Soc. Rev.* **2010**, *39*, 817; (c) L. J. Shi, L. B. Gan, *J. Phys. Org. Chem.* **2013**, *26*, 766.2.
2. (a) Noman, A. M.; Rahman, M.; Bishop, R. *Cryst Eng Comm*. **2003**, 5, 422-428 (b) Aakeroy, C. B.; Desper, J.; Helfrich, B. A. *Cryst Eng Comm*. **2004**, 6(5), 19–24.

Self-introduction

Name: Rui Gao(高锐)

Age: 26

Hometown: Liaoning, China

Education:

2011.9-2015.7 B.S., Zhejiang University,

2015.9-2018.6 M.S. Zhejiang University

2018.9-present Ph.D. Peking University. (with Professor Liangbing Gan)

Note

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