Research Accomplishments of the Condensed Matter Physics Laboratory, National Institute of Physics
01 January 2020 – 31 December 2020

ARNEL A. SALVADOR, Ph. D.
CMPL Program Coordinator
December 2020

I. Executive Summary

A. Activities of the Research Group

Organization

- Professor: 4
- Asst. Professor: 1
- REPS: 1
- Adjunct Researchers: 1
- PhD Physics Students: 10
- MS Physics Students: 12
- PhD MSE Students: 12
- MS MSE Students: 26
- Apprentices (NIP-Students): 2
- Apprentices (Non-NIP): 1
- Undergraduate Members: 21

Mentoring:

- PhD Physics: 1
- MS Physics: 1
- BS Physics: 4
- BS Applied Physics: 7
- PhD MSE: 1
- MS MSE: 1

B. Research Highlights

- Papers published/accepted for publications in international peer-reviewed journals: 14
- Papers published in local journals: 1
- International conference presentations
  - With full paper: 2
  - Without full paper: 5
- Local conference papers
  - With full paper: 13
  - Without full paper: 1
- NIP funded projects: 4
- Non-NIP funded projects: 7
- Major equipment acquired/upgraded: 2
- Research travels abroad: 1
- Visiting researchers: 0
- MOA's entered with foreign institutions: 0

C. Extension Work Highlights

- Activities: 5
- Research Interns/OJT's (Non-NIP), for trainings held at NIP: none, due to COVID-19
- Main Challenges Encountered and Proposed Solutions: 4

II. Technical Report

A. Activities of the Research Group

CMPL has five PhD faculty members with the National Institute of Physics. In July, after successfully earning his PhD, Dr. Alexander De los Reyes joins the laboratory as an Assistant Professor. Dr. Cyril Sadia-Salang, a faculty member of the Materials Science and Engineering Program and an alumna of CMPL, joins as an affiliated researcher. There are sixty graduate- and twenty-one undergraduate student members. The faculty and students of CMPL published 13 peer-reviewed Scopus-indexed manuscripts, an increase by 3 papers from 2019. CMPL members participated in local and international workshops and conferences conducted online. Laboratory meetings shifted to the online mode via Zoom. As some of the students moved to their home provinces, research work was partially done at home.

Due to the pandemic, internship programs were cancelled. Access to CMPL rooms was restricted to NIP faculty and staff, graduate students, and research staff of funded projects.

1.) Organization

a.) Group Members as of December 2020

PhD Faculty (5)

1.) Dr. Estacio, Elmer
2.) Dr. Salvador, Arnel
3.) Dr. Sarmago, Roland
4.) Dr. Somintac, Armando
5.) Dr. De Los Reyes, Alexander (as of July 26, 2020)

Adjunct Researcher (1)

Dr. Sadia-Salang, Cyril (since January 2020; affiliated with MSEP as faculty member)

REPS (1)

Singidas, Bess - CMPL URA

PhD Physics Students (10)

1.) Catindig, Gerald (P3)
2.) Cabello, Neil Irvin (P3+)
3.) De Los Reyes, Alexander (P3+)
4.) De Vera, Francesca Isabel (P3+)
5.) Husay, Horace Andrew (P3)
6.) Lumantas, Deborah Ann (P3+)
7.) Rillera, Angelo (P3)
8.) Singidas, Bess, (P3+)
9.) Solibet, Erick John Carlo (P3)
10.) Taguba, Jerome, NIP Instructor as of July 2020 (P5)

PhD MSE Students (12)

1.) Café, Arven I. (P3)
2.) Copa, Vernalyn (P3+)
3.) Faustino, Maria Angela B. (P3+)
4.) Jagus, Rommel J. (P3)
5.) Loberternos, Regine (P3)
6.) Montecillo, Anthony (P3)
7.) Publico, Jairrus (P2)
8.) Rosete, Maricar (P3+)
9.) Sayson, Luce Vida (P3)
10.) Tumanguil-Quitoras, Mae Agatha (P3+)
11.) Tingzon, Philippe Martin (P3+)
12.) Tuico, Anthony (P3+)

MS Physics Students (12)

1.) Ahmad, Al-Khadeem (M2+)
2.) Andig, Roni (M2+)
3.) Armonia, Jeremias-Ibus (M2+)
4.) Lipardo, John Axl (M2)
5.) Llemit, Christian Loer T. (M1)
6.) Lopez, Rusty (M2+)
7.) Ong, Ysabella Kassandra F. (M1)
8.) Romero, Ezekiel Raul (M2)
9.) Tacneng, Jonalds (M2+)
10.) Tan, Craig Allister (MS2+)
11.) Verona, Ivan Cedrick (M2)
12.) Vistro, Victor DC Andres (MS2+)

MS MSE Students (26)

1.) Aves, Ron Darell A. (M2+)
2.) Ballesteros, Laureen Ida (M2+)
3.) Bendal, Aldrin (M2+)
4.) Cantor, Camille Victoria (M2+)
5.) Cainglet, Michael Rey A. (M2+)
6.) De Luna, Charlene (M2+)
7.) Escaro, Archel (M2+)
8.) Escolano, Arvin Jay (M2+)
9.) Ferrolino, John Paul R. (M2+)
10.) Inguito, Jonah Micah L. (M2)
11.) Madula, Rogie M. (M2+)
12.) Magallanes, Bee Jay (M2)
13.) Manrique, Mylenne (M2+)
14.) Maylem, Genes P. (M2+)
15.) Mejarito, Vincent (MSE, M2+)
16.) Nalayog, Marvin B. (M2)
17.) Pangasinan, Jamela N. (M2+)
18.) Ramos, Ma. Romina Rogem V. (M1)
19.) Rola, Yuta Louie (M2+)
20.) Salazar, Kloudene (M2)
21.) Sura, Ar Jay C. (M2+)

22.) Torremoro, Jennieva Grace E. (M2)
23.) Valenzona, Marjorie (M2+)
24.) Vasquez, John Daniel (M2+)
25.) Veloz, Raymund (M2+)
26.) Vergara, Christopher Jude (M2+)

BS Physics (7)

1.) Figueroa, Nicole (B5+)
2.) Cavite, Theo Victor A. (B5)
3.) Ledesma, Anselmo Jose (B5+)
4.) Mataac, John Jerome G. (B5)
5.) Nueva, Angelo Gabriel (B5+)
6.) Galarosa, Nikko F. (B5+)
7.) Dela Rosa Lourdes Nicole (B5)

BS Applied Physics (14)

1.) Averell Aquino (B5+)
2.) Dagumanpan, Edu James (B5)
3.) Dawisan, Mark Kevin R. (B5)
4.) Guingab, Aizanel B. (B5)
5.) Juguilon, Vince Paul P. (B5+)
6.) Javar, Patricia (B5+)
7.) Leonardo, Shawntel Joy (B5+)
8.) Llevares, Kint Ynnos B. (B5+)
9.) Magsayo, Lawrence Jay G. (B5+)
10.) Mamucud, Karen Nicole E. (B5)
11.) Polido III, Wilfredo Miguel A (B5)
12.) Vasquez, Ardell Justin B. (B5+)
13.) Reyes, Giselle S. (B5)
14.) Subaldo, Mark Christian G. (B5+)

Apprentices (3)

Lim, Cerx Lorenz
Belila, Alexander Paul
Celebrado, Michelle

Organizational Summary

Member	Category	Number
PhD Faculty	Professor	4
	Assistant Professor	1
	Adjunct Researcher	1
Student Members	PhD Physics (1 REPS)	10
	PhD MSE	12
	MS Physics	12
	MS MSE	26
	BS	21
	Apprentices	3
Total		**90**

2.) Mentoring

A.) Graduates

Degree Program	Student	Thesis Title	Defense Date	Adviser	Graduated
PhD Physics	De Los Reyes, Alexander E.	*Low-Temperature Photocarrier Transport in MBE-Grown InAs/GaAs Quantum Dots Investigated via Photoluminescence and Terahertz Time-Domain Spectroscopy*	16 June 2020	Dr. Estacio, Elmer S.	2nd Sem, AY 19-20
PhD MSE	Rosete, Maricar	*Stabilization of $Bi_2Sr_2CaCu_2O_8$ in Ethanol with Supporting Electrolytes for the Enhancement of Electrophoretically Deposited Films*	22 Jul 2020	Dr. Sarmago, Roland V.	MY 2020
MS MSE	Galapia, Xyrus A.	*Electrophoretic Deposition and Two-step Sintering Approach for the Fabrication of Dense MgB2 Coatings on Copper Substrate*	10 Dec 2019	Dr. Sarmago, Roland V.	2nd Sem, AY 19-20
MS Physics (pick-up)	Rillera, Angelo P.	n.a.	n.a.	Dr. Sarmago, Roland V.	2nd sem, 19-20
BS Applied Physics Instrumentation	Dagumanpan, Edu James M.	*Gas Sensing Characterization on Graphene-based Chemiresistor Using Wheatstone Bridge*	not applicable - COVID-19	Dr. Salvador, Arnel A.	2nd sem 19-20
BS Applied Physics Instrumentation	Dawisan, Mark Kevin R.	*Reflectivity of Gallium Nitride (GaN)*	n. a. - COVID-19	Dr. Salvador, Arnel A.	2nd sem 19-20
BS Applied Physics Instrumentation	Mamucud, Karen Nicole E.	*Synthesis and Optical Activity of Iodine - Added ZnO Microrods Grown via Hydrothermal Method*	n. a. - COVID-19	Dr. Sarmago, Roland V.	2nd sem 19-20
BS Applied Physics Instrumentation	Ong, Ysabella Kassandra F.	*Sintering Behavior of CeO2 Films with KCl Fabricated via Sedimentation Deposition*	n. a. - COVID-19	Dr. Sarmago, Roland V.	2nd sem 19-20
BS Applied Physics Instrumentation	Ramos, Ma. Romina Rogem V.	*2D Mapping of Surface-enhanced Raman Spectroscopy of Methylene Blue Using Silver Nanowires*	n. a. - COVID-19	Dr. Somintac, Armando S.	2nd sem 19-20

BS Applied Physics Materials Physics	Guingab, Aizanel B.	*Investigation of the Effects of PbO Addition to the Bi-Sr-Ca-Cu-O (2234) System*	n. a. - COVID-19	Dr. Sarmago, Roland V.	2nd sem 19-20
BS Applied Physics Materials Physics	Llemit, Christian Loer T.	*First Principle Calculations of Defect Structures in Zinc Oxide*	n. a. - COVID-19	Dr. Sarmago, Roland V.	2nd sem 19-20
BS Physics	Bacaoco, Miguel Y.	*Photoreflectance Lineshape Analysis of ModulationDoped Heterostructures*	11 Dec 2017	Dr. Estacio, Elmer S.	2nd sem 19-20
BS Physics	Cavite, Theo Victor A.	*Device Fabrication of 1μm-gate length n-AlGaAs/GaAs HEMT*	n. a. - COVID-19	Dr. Salvador, Arnel A.	2nd sem 19-20
BS Physics	Mataac, John Jerome	*Fabrication and Characterization of a GaAs/Si top-top Contact Solar Cell*	n. a. - COVID-19	Dr. Salvador, Arnel A.	2nd sem 19-20
BS Physics	Polido III, Wilfredo Miguel A.	*Current-Voltage Characterization of Graphene Field Effect Transistors*	n. a. - COVID-19	Dr. Salvador, Arnel A.	2nd sem 19-20

Summary of Graduates

	2nd Sem AY AY 19-20	Midyear AY 19-20	1st Sem AY 19-20	Total
PhD Physics	1	0	0	1
PhD MSE	0	1	0	1
MS Physics	1	0	0	1
MS MSE	1	0	0	1
BS Applied Physics	7	0	0	7
BS Physics	4	0	0	4

B.) Research Highlights

1.) Papers published/accepted for publications in international and local peer-reviewed journal (15)

Science Citation Index/Scopus-indexed (13)

a.) A. Café, M. Bacaoco, C. Tugado, A. De Los Reyes, M.A. Faustino, L. Lopez, Jr., V. Hernandez, M. Mabanag, I. Lipardo, G.B. Tesoro, and E. Estacio, "Terahertz transmission spectroscopy of soil minerals for geoarchaeological evaluation of sediments excavated from Pinagbayanan Batangas Philippines," *Infrared Physics and Technology* **111**, 103568 (2020). https://doi.org/10.1016/j.infrared.2020.103568

b.) A. De Los Reyes, H. Bardolaza, J. D. Vasquez, N. I. Cabello, L. Lopez Jr., C. Y. Chang, A. Somintac, A. Salvador, D. J. Jang, and E. Estacio, "Temperature-dependent terahertz time-domain spectroscopy of 3D, 2D, and 0D semiconductor heterostructures,"

Journal of Materials Science: Materials in Electronics **31**, 6321 – 6327 (2020). https://doi.org/10.1007/s10854-020-03188-y

c.) A. E. De Los Reyes, J. D. Vasquez, H. R. Bardolaza, L. P. Lopez, C.-Y. Chang, A. S. Somintac, A. A. Salvador, D.-J. Jang, and E. S. Estacio, "Low-temperature carrier dynamics in MBE-grown InAs/GaAs single- and multi-layered quantum dots investigated via photoluminescence and terahertz time-domain spectroscopy," *Optical Materials Express* **10**, 178 – 186 (2020). https://doi.org/10.1364/OME.380909

d.) B. Singidas, A. De Los Reyes, H. Bardolaza, J.D. Vasquez, A. Salvador, E. Estacio, and R. Sarmago, "Graphene transfer passivates GaAs," *Applied Physics Letters* **117**(17), 171105 (2020). https://doi.org/10.1063/5.0015145

e.) J. Afalla, A. De Los Reyes, N.I. Cabello, V. DC. A. Vistro, M.A. Faustino, J.P. Ferrolino, E.A. Prieto, H. Bardolaza, G.A. Catindig, K.C. Gonzales, V.K. Mag-usara, H. Kitahara, A. Somintac, A. Salvador, M. Tani, and E. Estacio, "A modulation-doped heterostructure-based terahertz photoconductive antenna emitter with recessed metal contacts," *Scientific Reports* **10**, 19926 (2020). https://doi.org/10.1038/s41598-020-76413-7

f.) J. Afalla, G. Catindig, A. De Los Reyes, E. Prieto, M. A. Faustino, V. DC Vistro, K. C. Gonzales, H. Bardolaza, V. K. Mag-usara, H. A. Husay, J. Muldera, N. I. Cabello, J. P. Ferrolino, H. Kitahara, A. Somintac, A. Salvador, M. Tani, and E. Estacio, "Ultrafast carrier dynamics and THz conductivity in epitaxial-grown LT-GaAs on silicon for development of THz photoconductive antenna detectors," *Journal of Physics D: Applied Physics* **53**, 095105 (2020). https://doi.org/10.1088/1361-6463/ab5aa7

g.) M. Rosete, M. Zosa, and R. Sarmago, "Improved Fabrication of Electrophoretically Deposited Bi2Sr2CaCu2O8 Films via Supporting Electrolyte Optimization in Ethanol," *Journal of Superconductivity and Novel Magnetism* accepted manuscript (2020). https://doi.org/10.1007/s10948-020-05668-y

h.) E.A Prieto, A. De Los Reyes, V.DC Vistro, N.I. Cabello, M.A. Faustino-Lopez, J.P. Ferrolino, J.D. Vasquez, H. Bardolaza, J.P. Afalla, V.K. Mag-usara, H. Kitahara, M. Tani, A. Somintac, A. Salvador, and E. Estacio, "Trilayer low-temperature-grown GaAs terahertz emitter and detector device with doped buffer," *Applied Physics Express* **13**, 082012 (2020). https://doi.org/10.35848/1882-0786/aba9a2

i.) E.J. Solibet, R. Veloz, M.J. Empizo, H.A. Husay, K. Kawano, K. Yamanoi, T. Shimizu, N. Sarukura, E. Estacio, A. Salvador, and A. Somintac, "Spray Pyrolysis Deposition of Al-Doped ZnO Thin Films for Potential Picosecond Extreme Ultraviolet Scintillator Applications," *Physica Status Solidi (B)* **257**(8), 1900481 (2020). https://doi.org/10.1002/pssb.201900481

j.) H. Bardolaza, M. A. Faustino-Lopez, M. Bacaoco, J. P. Ferrolino, I. C. Verona, V. D. C. A. Vistro, N. I. Cabello, L. Lopez Jr., A. De Los Reyes, A. Somintac, A. Salvador, and E. Estacio, "Observation of enhanced terahertz emission in two-dimensional metal line

arrays on GaAs surfaces," *Japanese Journal of Applied Physics* **59**, 070907 (2020). https://doi.org/10.35848/1347-4065/ab9ba0

k.) M.C. Escano, M.H. Balgos, T.Q. Nguyen, E.A. Prieto, E. Estacio, A. Salvador, A. Somintac, R. Jaculbia, N. Hayazawa, Y. Kim, and M. Tani, "True bulk As-antisite defect in GaAs (110) identified by DFT calculations and probed by STM/STS measurements," *Applied Surface Science* **511**, 145590 (2020). https://doi.org/10.1016/j.apsusc.2020.145590

l.) M. Balmeo, J.S. Dizon, M. J. Empizo, E.J.C. Solibet, V. Agulto, A. Salvador, N. Sarukura, H. Nakanishi, H. Kasai, and A. Padama, "Density functional theory-based investigation of hydrogen adsorption on zinc oxide surface: Revisited," *Surface Science* **703**, 121726 (2020). https://doi.org/10.1016/j.susc.2020.121726

m.) T. Hayasaka, A. Lin, V.C. Copa, L.P. Lopez, Jr., R. Loberternos, L.I. Ballesteros, Y. Kubota, Y. Liu, A. Salvador, and L. Lin, "An electronic nose using a single graphene FET and machine learning for water, methanol, and ethanol," *Microsystems and Nanoengineering* **6** (1), 50 (2020). https://doi.org/10.1038/s41378-020-0161-3

Non Science Citation Index/Scopus-indexed (2)

n.) Lopez Jr, L., Copa, V., Hayasaka, T., Faustino‐Lopez, M.A., Wu, Y., Liu, H., Liu, Y., Estacio, E., Somintac, A., Lin, L. and Salvador, A., Influence of chamber design on the gas sensing performance of graphene field‐effect‐transistor. SN Applied Sciences (2020) 2:1185 | https://doi.org/10.1007/s42452-020-2676-5

o.) M. Y. Bacaoco, V. P. Juguilon, Arven I. Cafe, Catherine A. Tugado Maria Angela B. Faustino, Gerry Bagtasa, Elmer S. Estacio, Design of a Low-cost Differential Optical Absorption Spectroscopy Set-up for Simultaneous Monitoring of Atmospheric NO2 Concentration and Aerosol Optical Thickness. Science Diliman (July-December 2020) 32:2, 25-41

2.) International conference presentations with full paper in print proceedings (2):

a.) J.P. Ferrolino, N.I. Cabello, A. De Los Reyes, V.K. Mag-Usara, J.P. Afalla, H. Bardolaza, I.C. Verona, M. Talara, H. Kitahara, A. Somintac, A. Salvador, M. Tani, and E. Estacio, "Spintronic terahertz emission from Ni/Pt bilayer grown on MgO," in Proceedings of the 10th International Seminar on New Paradigm and Innovation of Natural Sciences and Its Applications (10th ISNPINSA), Semarang, Indonesia, 24-25 September 2020.

b.) N. I. Cabello, A. De Los Reyes, J. Lopez, V. Sarmiento, J. P. Ferrolino, M. A. Faustino, V. D. A. Vistro, C. Yu, J. D. Vasquez, H. Bardolaza, M. Talara, M. Shiihara, V. Mag-usara, J. Afalla, M. Tani, A. Salvador, A. Somintac, and E. Estacio, "Enhanced terahertz emission of silicon nanowire-coated gallium arsenide photoconductive antenna," in 14th Pacific Rim Conference on Lasers and Electro-Optics (CLEO PR 2020), Sydney Australia, 3–5 August 2020.

3.) International conference presentations WITHOUT full paper (5):

a.) M. J. F. Empizo, K. Yamanoi, V. C. Agulto, E. J. C. D. Solibet, M. M. Balmeo, J. S. C. Dizon, A. A. B. Padama, V. A. I. Samson, T. Shimizu, R. V. Sarmago, N. Sarukura, and A. A. Salvador, "Experimental and theoretical investigations on the effects of hydrogen on bulk ZnO single crystal surfaces," (Poster Presentation) in the Conference on Laser and Synchrotron Radiation Combination Experiment (LSC2020) held online from April 20 to 24, 2020.

b.) V. C. Agulto, M. J. F. Empizo, K. Kawano, Y. Minami, K. Yamanoi, N. Sarukura, A. C. C. Yago, and R. V. Sarmago, "Investigation of Cu-doped ZnO microrods using photoluminescence spectroscopy and x-ray absorption near-edge spectroscopy," (Poster Presentation) in the Conference on Laser and Synchrotron Radiation Combination Experiment (LSC2020) held online from April 20 to 24, 2020.

c.) K. Salazar, V. A. Samson, J. M. Inguito, N. Sarukura, M. J. Empizo, V. C. Agulto, P. Kidkhunthod, S. Sattayapornttayaporn, and R. Sarmago, "X-ray absorption spectroscopy analysis of Fe-doped ZnO," (Poster Presentation) in the Conference on Laser and Synchrotron Radiation Combination Experiment (LSC2020) held online from April 20 to 24, 2020.

d.) M. J. F. Empizo, E. J. C. D. Solibet, M. A. H. Zosa, V. C. Agulto, Y. Minami, K. Yamanoi, T. Shimizu, A. A. B. Padama, V. A. I. Samson, A. S. Somintac, R. V. Sarmago, A. A. Salvador, and N. Sarukura, "Grazing incidence x-ray diffraction spectroscopy of non-irradiated and D-ion plasma-irradiated bulk ZnO single crystals," (Poster Presentation) in the Conference on Laser and Synchrotron Radiation Combination Experiment (LSC2020) held online from April 20 to 24, 2020.

e.) Hernanie Salazar, Der-Jun Jang, Xuan-dung Mai, Kuong-Ngai Ng, Che-yu Chang, Phoebe Nicole Perez, Arvin Lester C Jusi, Roland Sarmago, Li-Wei Tu, Wang-Chi Yeh, Feng-chuan Chuang, Meng-En Lee, "Temperature-dependent photoluminescence of carbon quantum dots" APS March Meeting 2020, Session U65: Superlattices and Nanostructures III: Optical Phenomena, held Thursday, March 5, 2020 in Denver, Colorado

4.) Local conference presentations

With full paper in print proceedings (13)

a.) Rillera, Y.K. Ong, and R. Sarmago, "Enhanced sinterability of CeO2 on Haynes 230," Proceedings of the Samahang Pisika ng Pilipinas 38, SPP-2020-3A-10 (2020). URL: https://proceedings.spp-online.org/article/view/SPP-2020-3A-10 .

b.) C.S. Salang, D.V.J.C. Narag, R. Jagus, C.E.A.D. Tan, G.A.R. Catindig, R. Andig, M.A.C. Tumanguil-Quitoras, A. De Los Reyes, I.C.M. Verona, H.R. Bardolaza, A.S. Somintac, A.A. Salvador, and E.S. Estacio, "Terahertz emission from MBE-grown

InGaAs/InP and InAs/GaSb films excited by 1550 nm femtosecond laser pulses," Proceedings of the Samahang Pisika ng Pilipinas 38, SPP-2020-2F-04 (2020). URL: https://proceedings.spp-online.org/article/view/SPP-2020-2F-04.

c.) C.V.M. Cantor and R.V. Sarmago, Well-dispersed YBCO in acetone via planetary milling," Proceedings of the Samahang Pisika ng Pilipinas 38, SPP-2020-5G-01 (2020). URL: https://proceedings.spp-online.org/article/view/SPP-2020-5G-01.

d.) E.J.C.D. Solibet, M.J.F. Empizo, M.C.M. Angub, C.J.T. Vergara, H.A.F. Husay, V.C. Agulto, K. Yamanoi, T Shimizu, E.S. Estacio, A.A. Salvador, N. Sarukura, and A.S. Somintac, "Room-temperature optical emission properties of hydrothermal grown zinc oxide nanostructures," Proceedings of the Samahang Pisika ng Pilipinas 38, SPP-2020-2C-02 (2020). URL: https://proceedings.spp-online.org/article/view/SPP-2020-2C-02.

e.) E.R.D. Romero, J.A. Lipardo, R. Sarmago, and V.A. Samson, "Comparison of two simulation approaches for a first-generation transmission type gamma computed tomography," Proceedings of the Samahang Pisika ng Pilipinas 38, SPP-2020-4A-05 (2020). URL: https://proceedings.spp-online.org/article/view/SPP-2020-4A-05.

f.) F.I.N. de Vera, N.D. Fernandez, J. Tacneng, H. Chou, and R. Sarmago, "Transport properties of In-added Bi2Sr2CaCu2O8+d thick films," Proceedings of the Samahang Pisika ng Pilipinas 38, SPP-2020-5G-04 (2020). URL: https://proceedings.spp-online.org/article/view/SPP-2020-5G-04.

g.) I.C.M. Verona, J.P. Ferrolino, A. De Los Reyes, H.. Bardolaza, N.I. Cabello, A. Somintac, A. Salvador, and E. Estacio, "Spintronic terahertz emission of Ni/Pt on GaAs using 1550 nm fiber laser," Proceedings of the Samahang Pisika ng Pilipinas 38, SPP-2020-2F-03 (2020). URL: https://proceedings.spp-online.org/article/view/SPP-2020-2F-03.

h.) J.C. Taguba and R.V. Sarmago, "X-ray diffraction analysis of strontium-doped lanthanum cobaltite powder prepared from an aqueous precursor solution," Proceedings of the Samahang Pisika ng Pilipinas 38, SPP-2020-4F-05 (2020). URL: https://proceedings.spp-online.org/article/view/SPP-2020-4F-05.

i.) J.G. Torremoro, J.C. Taguba, and R.V. Sarmago, "High purity YBCO powder prepared using acetate based sol-gel method," Proceedings of the Samahang Pisika ng Pilipinas 38, SPP-2020-5G-03 (2020). URL: https://proceedings.spp-online.org/article/view/SPP-2020-5G-03.

j.) K.N.E. Mamucud, K.A. Salazar, V.C. Agulto, M.J.F. Empizo, K. Shinohara, K. Yamanoi, T. Shimizu, N. Sarukura, and R.V. Sarmago, "Synthesis and optical activity of KI-added ZnO microrods grown via hydrothermal method," Proceedings of the Samahang Pisika ng Pilipinas 38, SPP-2020-5G-02 (2020). URL: https://proceedings.spp-online.org/article/view/SPP-2020-5G-02.

k.) M.R.R.V. Ramos, H.A.F. Husay, J. Ibus-Armonia, and A.S. Somintac, "Optimization by 2D mapping of the Surface-Enhanced

Raman Spectroscopy of methylene blue using silver nanowires," Proceedings of the Samahang Pisika ng Pilipinas 38, SPP-2020-5G-06 (2020). URL: https://proceedings.spp-online.org/article/view/SPP-2020-5G-06.

l.) V.C. Agulto, M.J.F. Empizo, J.M.L. Inguito, B.J. Magallanes, M.B. Nalayog, K. Shinohara, D. Umeno, K.A. Salazar, E.J.C.D. Solibet, J. Ibus-Armonia, M.A.N. Judicpa, A.S. Somintac, K. Yamanoi, T. Shimizu, A.C.C. Yago, R.V. Sarmago, and N. Sarukura, "Spectroscopic investigations of ZnO-polymer composites grown via wet chemical method," Proceedings of the Samahang Pisika ng Pilipinas 38, SPP-2020-2C-04 (2020). URL: https://proceedings.spp-online.org/article/view/SPP-2020-2C-04 .

m.) BYG Tinte, J De Mesa, A Rillera, R Sarmago, and W Garcia, Surface morphology of cerium oxide ablated by femtosecond-pulsed laser with varying target scanning speeds, Proceedings of the Samahang Pisika ng Pilipinas 38, SPP-2020-3A-09 (2020). URL: https://proceedings.spp-online.org/article/view/SPP-2020-3A-09.

Without full paper (1)

A. A Salvador, "Graphene field effect transistors as gas sensors: Lessons learned in new collaborations," Proceedings of the Samahang Pisika ng Pilipinas 38, SPP-2020-INV-2F-01 (2020). URL: https://proceedings.spp-online.org/article/view/SPP-2020-INV-2F-01 .

7.) NIP-funded Projects (4)

a.) Leader: Dr. Estacio, Elmer S.
Title: *Generation of spintronic terahertz emission from Nickel/Platinum thin films deposited on magnesium oxide via Ebeam*
Duration: 01 January – 31 December 2020

b.) Leader: Dr. Salvador, Arnel A.
Title: Graphene gas sensors
Duration: 01 January – 31 December 2020

c.) Leader: Dr. Sarmago, Roland V.
Title: *Electrophoretic deposition of Bi-Sr-Ca-Cu-O Superconductors*
Duration: 01 January – 31 December 2020

d.) Leader: Dr. Somintac, Armando S.
Title: *Pyroelectric properties of Iron Oxide gas-based composite materials*
Duration: 01 January – 31 December 2020

8.) Non-NIP funded projects (7):

a.) Leader: Dr. Sarmago, Roland V.
Title: *Fabrication of Highly c-axis Oriented YBCO Superconducting Thin Films by Sedimentation Deposition*
Duration: 01 March 2017 – 31 July 2020

Amount: PHP 16,387,305
Funding Agency: DOST-PCIEERD GIA 03547

b.) Leader: Dr. Estacio, Elmer S.
Title: *Design and fabrication of a photoconductive antenna array for terahertz application*
Duration: 01 February – 31 January 2021
Amount: PHP 300,000.00
Funding Agency: UP-OVCRD

c.) Leader: Dr. Salang, Cyril S.
Title: *InGaAs-based mismatched heterostructures for terahertz emission*
Duration: 01 February 2020 - 31 January 2021
Amount: Php 300,000.00
Funding Agency: UP - OVCRD

d.) Leader: Dr. Salang, Cyril S.
Title: *Exfoliation and characterization of graphene 2D nanomaterials*
Duration: 01 January 2020 - 31 December 2020
Amount: Php 300,000.00
Funding Agency: UP – NSRI

e.) Leader: Dr. Salvador, Arnel A.*
Title: *Terahertz emission enhancement in GaAs on Si (100) utilizing two-step low-temperature GaAs system*
Duration: 13 Jan 2020 - 12 January 2021
Amount: P300,000.00
Funding Agency: UP-OVCRD

f.) Leader: Dr. Salvador, Arnel A.
Title: *Radiation damage investigations on functional materials: Material development, analysis, and informatics*
Duration: 1 April 2019 to 31 March 2021
Amount: P2,009,190.00
Funding Agency: DOST-JSPS

g.) Co-project Leader: De Los Reyes, Alexander E.*
Project Title: *MBE thin film growth of RTD heterostructures*
Project Duration: 1 Jan 2020 to 31 Dec 2020
Amount: P657,179.49
Funding Agency: UP-NSRI

** previously under Dr. Prieto, Elizabeth Ann*

9.) Major equipment acquired/upgraded (2)

a.) One Lot High Resolution Triple Grating Spectrometer
Cost: PHP 7,499,000.00
Mode of Acquisition: UPD Office of the Chancellor
Project Leader: Roland Sarmago

b.) Vienna Ab Initio Simulation Package
Cost: PHP 400,000.00
Mode of Acquisition: PCIEERD GIA03547
Project Leader: Roland Sarmago

10.) Research Travels Abroad (1)

Roland V. Sarmago
Purpose: as Visiting Researcher
Place: Institute of Laser Engineering, Osaka University
Dates: 8-29 March 2020
Mode of Exchange: MOA

C.) Extension Highlights

1.) Extension Work Activities (5)

a.) Dr. Estacio, Elmer S.
as Lecturer, "Generation of Pulsed Terahertz Radiation in Semiconductor Materials and Antenna Devices Using Ultrafast Laser Excitation: Theory and Applications"
Event: 2020 APAMS, 11 September, 2020

b.) Dr. Estacio, Elmer S.
as Lecturer, "Terahertz electromagnetic pulse generation in semiconductor materials and devices: Theory and applications"
Event: International School on Photonics and Applications, Hanoi Vietnam, 1-3 November 2020

c.) Dr. Estacio, Elmer S.
as Keynote Speaker, "Recent Progress in Terahertz Photoconductive Antenna Device Research at the University of the Philippines"
Event: The 3rd International Conference on Radiation and Emission in Materials, Chiang Mai University Chiang Mai, Thailand, 15-18 December 2020

d.) Dr. De Los Reyes, Alexander E.
as Keynote Speaker, "Options for Remote Lab Activities in Physics"
Event: API on Teaching Science Laboratory Courses in a Remote Learning Scenario, University of the Philippines Visayas, 11 November – 2 December, 2020

e.) Dr. Salvador, Arnel A
as Conference Co-chair (Steering Committee)
Event: Conference on Laser and Synchrotron Radiation Combination Experiment 2020 (LSC2020), Pacifico Yokohama, Yokohama, Japan (held online due to COVID-19), April 22 – 24, 2020

2.) Research Interns/OJT's (Non-NIP), for trainings held at NIP

*Cancelled due to COVID-19

D.) Main Challenges Encountered and Proposed Solutions

Main Challenges Encountered	Proposed Solutions
NIP Access – Due to access and quarantine restrictions brought by COVID19, it has been difficult to enter premises of NIP to perform maintenance check and equipment	A detailed guideline for non-UP employed and undergraduate students would help in implementing NIP access restrictions. However,

	this is subject to the approval of the UP administration.
Supplies – Due to payment delay of previous orders, new supplies were withheld. These resulted to the delay in the experiment and thesis of the student	A proper document tracking system is recommended. A proper inventory of remaining chemicals and supplies could also be performed.
Equipment – Downtime of equipment or delay in purchase affects the experiment and thesis of the student.	It is recommended to fast-track the purchase of equipment to avoid delay for both project and/or thesis related deliverables. Budget for maintenance and upkeep of equipment should be included in research proposals.
Bad internet connectivity at times, lack of access to good internet subscription, and troubles with electronic devices made it difficult to reach some students. Some students also suffered from mental health issues.	Maintain constant communication with the students through several modes aside from internet, such as SMS. Include communication expenses for work from home in LIBs of funded projects.

E.) Awards or Accreditations Received / Positions of Responsibility Held and Other Accomplishments

1.) Dr. Estacio, Elmer S.
Second Vice-President
Samahang Pisika ng Pilipinas

2.) Dr. Salang, Cyril S.
Secretary General
Samahang Piska ng Pilipinas

3.) Dr. Somintac, Armando S.
Director, Project Management and Research Generation Office
Office of the Vice-Chancellor for Research and Development
University of the Philippines Diliman

III. Photos, ISI/SCI publications and other Appendices

Figure 1. CMPL PhD Researchers (From Left to Right, Top: Dr. Salvador, Dr. Sarmago, Dr. Somintac, and Dr. Estacio; Bottom, Dr. De Los Reyes (Left), and Dr. Salang (Right) (From:http://nip.upd.edu.ph/people/faculty/professors/ and Dr. Salang's LinkedIn)

Figure 2. Christmas Party of the Supercon group via Zoom. December 2020

Figure 3. Dr. Roland Sarmago at the Institute of Laser Engineering, Osaka University with collaborators Prof. Nobuhiko Sarukura, Dr. Jacque Lynn F. Gabayno and Ms. Verdad Agulto. March 2020.

Abstracts of Peer Reviewed Articles (through screen capture from the journal website or 1st page of pdf file)

Infrared Physics & Technology
Volume 111, December 2020, 103568

Regular article

Terahertz transmission spectroscopy of soil minerals for geoarchaeological evaluation of sediments excavated from Pinagbayanan Batangas Philippines

Arven I. Cafe [a, b], Miguel Bacaoco [b], Catherine Tugado [a, b], Alexander De Los Reyes [b], Maria Angela Faustino [a, b], Lorenzo Lopez Jr. [a, b], Vito Hernandez [c, d], Mark Mabanag [c], Ian Lipardo [c], Grace Barretto Tesoro [c], Elmer S. Estacio [a, b]

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https://doi.org/10.1016/j.infrared.2020.103568

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Abstract

Sediments consisting of different soil minerals were collected from an archaeological site located in Pingabayanan Batangas Philippines. Each of the soil samples from selected layers or sampling depth was examined and profiled. Standard characterization techniques such as XRF, XRD, and FTIR spectroscopy were then performed for elemental and crystal analysis. All three aforementioned characterization techniques are in good agreement with the archaeological descriptions of sediments profile. Moreover, terahertz (THz) transmission spectroscopy was also performed to explore the feasibility of utilizing this novel spectroscopy for characterizing soil minerals. Terahertz time-domain spectroscopy (THz-TDS) results show good agreement to the standard characterization results in terms of detection of trace metals and minerals. Hence, the THz transmission spectra can provide necessary information related to the sedimentation profile and archaeological recordings that were conducted. Results suggest that THz-TDS may prove as a quick and non-destructive method to study soil samples, complementary to standard techniques for geoarchaeological surveys.

Springer Link

Published: 06 March 2020

Temperature-dependent terahertz time-domain spectroscopy of 3D, 2D, and 0D semiconductor heterostructures

Alexander De Los Reyes ✉, Hannah Bardolaza, John Daniel Vasquez, Neil Irvin Cabello, Lorenzo Lopez Jr., Che-Yung Chang, Armando Somintac, Arnel Salvador, Der-Jun Jang ✉ & Elmer Estacio

Journal of Materials Science: Materials in Electronics **31**, 6321–6327(2020) | Cite this article

125 Accesses | Metrics

Abstract

Carrier transport in semiconductors with different dimensionalities, i.e., 3D (bulk), 2D (QW), and 0D (QD), were investigated via temperature-dependent terahertz time-domain spectroscopy (THz-TDS). The optical properties and recombination dynamics in the samples were probed via photoluminescence spectroscopy. The temperature-dependence of the THz emission from the samples was explained in the context of the drift-diffusion model using the dominant THz radiation mechanism. The THz emission from diffusion-type THz emitters such as p- and n-InAs decreases as temperature increases due to mobility decrease. Conversely, the THz emission from drift-type THz emitters such as SI-GaAs, GaAs QW, and InAs QD was found to increase with temperature due to the increase in the driving electric field. In summary, THz-TDS can be utilized to gain qualitative insights on the temperature-dependent transport characteristics and establish dominant THz radiation mechanisms.

Research Article | Vol. 10, No. 1 / 1 January 2020 / Optical Materials Express 178

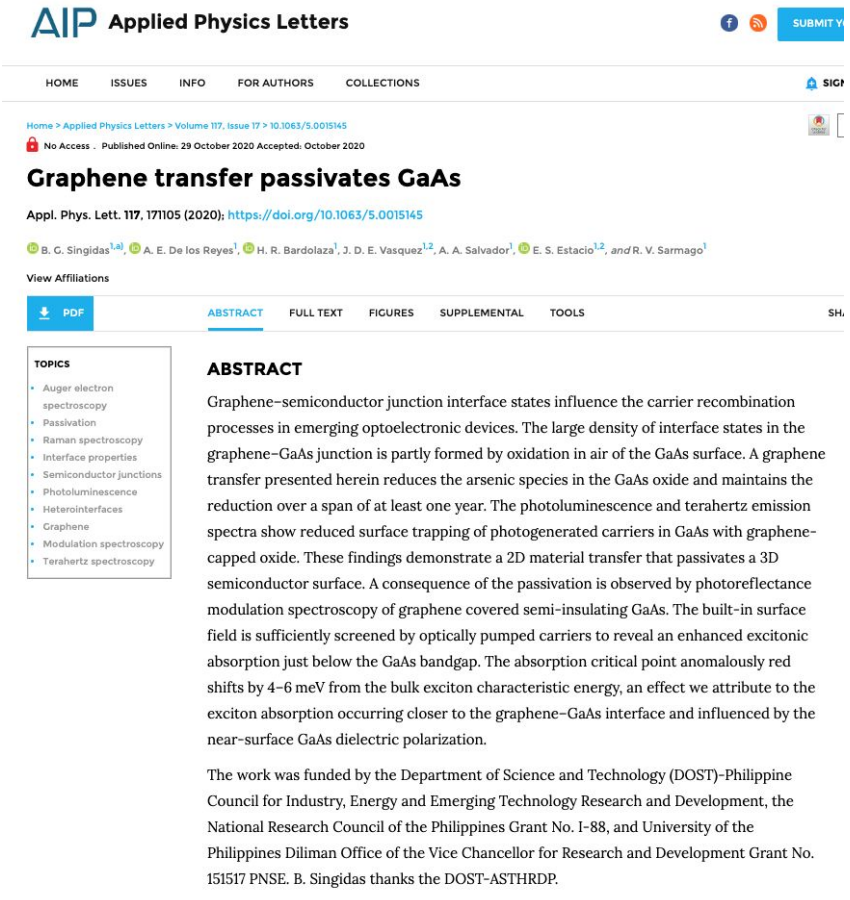
Optical Materials EXPRESS

Low-temperature carrier dynamics in MBE-grown InAs/GaAs single- and multi-layered quantum dots investigated via photoluminescence and terahertz time-domain spectroscopy

ALEXANDER E. DE LOS REYES,[1,*] JOHN DANIEL VASQUEZ,[1,2] HANNAH R. BARDOLAZA,[1,2] LORENZO P. LOPEZ JR.,[1,2] CHE-YUNG CHANG,[3] ARMANDO S. SOMINTAC,[1] ARNEL A. SALVADOR,[1] DER-JUN JANG,[3] AND ELMER S. ESTACIO[1,2]

[1] *National Institute of Physics, University of the Philippines Diliman, Quezon City 1101, Philippines*
[2] *Materials Science and Engineering Program, University of the Philippines Diliman, Quezon City 1101, Philippines*
[3] *Department of Physics, National Sun-Yat-Sen University, Kaohsiung 80424, Taiwan, ROC*
[*] *adelosreyes@nip.upd.edu.ph*

Abstract: The photocarrier dynamics in molecular beam epitaxy (MBE)-grown single- (SLQD) and multi-layered (MLQD) InAs/GaAs quantum dots were studied. Photoluminescence (PL) spectroscopy has shown that the MLQD has more uniform QD size distribution as compared to the bimodal SLQD. Correlation between PL and THz-TDS has shown that photocarrier transport is more favored in the MLQD owing to this uniform QD size distribution, resulting to higher THz emission. The THz emission from the QD samples were found to be proportional to temperature. A drift-related photocarrier transport mechanism is proposed, wherein photocarriers generated in the QDs are accelerated by an interface electric field.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No Access . Published Online: 29 October 2020 Accepted: October 2020
Graphene transfer passivates GaAs
Appl. Phys. Lett. 117, 171105 (2020); https://doi.org/10.1063/5.0015145
B. G. Singidas[1,a], A. E. De los Reyes[1], H. R. Bardolaza[1], J. D. E. Vasquez[1,2], A. A. Salvador[1], E. S. Estacio[1,2], and R. V. Sarmago[1]
View Affiliations
PDF
ABSTRACT
FULL TEXT
FIGURES
SUPPLEMENTAL
TOOLS
TOPICS
Auger electron spectroscopy
Passivation
Raman spectroscopy
Interface properties
Semiconductor junctions
Photoluminescence
Heterointerfaces
Graphene
Modulation spectroscopy
Terahertz spectroscopy
ABSTRACT
Graphene–semiconductor junction interface states influence the carrier recombination processes in emerging optoelectronic devices. The large density of interface states in the graphene–GaAs junction is partly formed by oxidation in air of the GaAs surface. A graphene transfer presented herein reduces the arsenic species in the GaAs oxide and maintains the reduction over a span of at least one year. The photoluminescence and terahertz emission spectra show reduced surface trapping of photogenerated carriers in GaAs with graphene-capped oxide. These findings demonstrate a 2D material transfer that passivates a 3D semiconductor surface. A consequence of the passivation is observed by photoreflectance modulation spectroscopy of graphene covered semi-insulating GaAs. The built-in surface field is sufficiently screened by optically pumped carriers to reveal an enhanced excitonic absorption just below the GaAs bandgap. The absorption critical point anomalously red shifts by 4–6 meV from the bulk exciton characteristic energy, an effect we attribute to the exciton absorption occurring closer to the graphene–GaAs interface and influenced by the near-surface GaAs dielectric polarization.
The work was funded by the Department of Science and Technology (DOST)-Philippine Council for Industry, Energy and Emerging Technology Research and Development, the National Research Council of the Philippines Grant No. I-88, and University of the Philippines Diliman Office of the Vice Chancellor for Research and Development Grant No. 151517 PNSE. B. Singidas thanks the DOST-ASTHRDP.

Article | Open Access | Published: 16 November 2020

A modulation-doped heterostructure-based terahertz photoconductive antenna emitter with recessed metal contacts

Jessica Afalla, Alexander De Los Reyes, Neil Irvin Cabello, Victor DC Andres Vistro ✉, Maria Angela Faustino, John Paul Ferrolino, Elizabeth Ann Prieto, Hannah Bardolaza, Gerald Angelo R. Catindig, Karl Cedric Gonzales, Valynn Katrine Mag-usara, Hideaki Kitahara, Armando S. Somintac, Arnel A. Salvador, Masahiko Tani & Elmer S. Estacio ✉

Scientific Reports **10**, Article number: 19926 (2020) | Cite this article

Abstract

We present the implementation of an efficient terahertz (THz) photoconductive antenna (PCA) emitter design that utilizes high mobility carriers in the two-dimensional electron gas (2DEG) of a modulation-doped heterostructure (MDH). The PCA design is fabricated with recessed metal electrodes in direct contact with the 2DEG region of the MDH. We compare the performance of the MDH PCA having recessed contacts with a PCA fabricated on bulk semi-insulating GaAs, on low temperature-grown GaAs, and a MDH PCA with the contacts fabricated on the surface. By recessing the contacts, the applied bias can effectively accelerate the high-mobility carriers within the 2DEG, which increases the THz power emission by at least an order of magnitude compared to those with conventional structures. The dynamic range (62 dB) and bandwidth characteristics (3.2 THz) in the power spectrum are shown to be comparable with the reference samples. Drude-Lorentz simulations corroborate the results that the higher-mobility carriers in the MDH, increase the THz emission. The saturation characteristics were also measured via optical fluence dependence, revealing a lower saturation value compared to the reference samples. The high THz conversion efficiency of the MDH-PCA with recessed contacts at low optical power makes it an attractive candidate for THz-time domain spectroscopy systems powered by low power fiber lasers.

Journal of Physics D: Applied Physics

PAPER

Ultrafast carrier dynamics and THz conductivity in epitaxial-grown LT-GaAs on silicon for development of THz photoconductive antenna detectors

Jessica Afalla[6,1], Gerald Catindig[2], Alexander De Los Reyes[2], Elizabeth Prieto[5,2], Maria Angela Faustino[2,4], Victor DC Vistro[2], Karl Cedric Gonzales[2], Hannah Bardolaza[2], Valynn Katrine Mag-usara[1], Horace Andrew Husay[2] + Show full author list

Published 20 December 2019 • © 2019 IOP Publishing Ltd

Journal of Physics D: Applied Physics, Volume 53, Number 9

Citation Jessica Afalla *et al* 2020 *J. Phys. D: Appl. Phys.* **53** 095105

+ Article information

Abstract

Carrier dynamics and photoconductivity in epitaxial-grown low-temperature GaAs on nominal and vicinal Si(100) substrates ('LT-GaAs/Si') were studied to predict their actual performance as THz photoconductive antenna (PCA) detectors. An optical-pump terahertz-probe technique was used to obtain the transmittance, carrier lifetime and photoconductivity of two LT-GaAs/Si samples, grown using different substrates and different growth protocols. The LT-GaAs grown on Si(100) substrate with a 4° tilt to 〈110〉 has better crystallinity, in agreement with other reports; while the LT-GaAs layer grown on nominal Si(100) substrate, though more structurally defective, has a much faster electron trapping time. Fabricated test PCAs with either dipole or bowtie geometries confirm the characterization results. The photoconductivity and carrier lifetime results manifest in the PCA performance, in responsivity, and in detection bandwidth. The prototypes' sensitivities, bandwidths and dynamic ranges show that with some growth optimization, LT-GaAs/Si can be tailored to create economical, broadband THz detectors.

Springer Link

Original Paper | Published: 16 September 2020

Improved Fabrication of Electrophoretically Deposited $Bi_2Sr_2CaCu_2O_8$ Films via Supporting Electrolyte Optimization in Ethanol

M. M. Rosete ✉, MA. H. Zosa & R. V. Sarmago

Journal of Superconductivity and Novel Magnetism **34**, 55–61(2021) | Cite this article

37 Accesses | Metrics

Abstract

This paper describes the effect of the addition of supporting electrolytes sodium chloride (NaCl), potassium chloride (KCl), and lithium chloride (LiCl) on the stability of $Bi_2Sr_2CaCu_2O_8$ (Bi-2212) suspension for improved electrophoretic deposition (EPD) of Bi-2212 films. The optimal concentrations are found to be 7.15, 5.21, and 8.09 wt% for NaCl, KCl, and LiCl, respectively. They exhibit characteristic high zeta potential, small particle size, and low settling velocity entailing that well-stabilized Bi-2212 suspensions are produced. The resulting films possess a relatively smooth surface, high transition temperature (T_c), and high c-axis orientation. Further analysis shows that LiCl is the most suitable supporting electrolyte for the Bi-2212 suspension. The mechanism of action of this supporting electrolyte is influenced by the Hofmeister effects, which yields an electrostatic stabilization mechanism. The synthesized film using the optimal LiCl concentration demonstrates the highest T_c (87.25 K) and is c-axis oriented and well-textured.

Applied Physics Express

LETTER

Trilayer low-temperature-grown GaAs terahertz emitter and detector device with doped buffer

Elizabeth Ann Prieto[1,2], Alexander De Los Reyes[1], Victor DC Andres Vistro[1], Neil Irvin Cabello[1], Maria Angela Faustino[2], John Paul Ferrolino[2], John Daniel Vasquez[2], Hannah Bardolaza[2], Jessica Pauline Afalla[3], Valynn Katrine Mag-usara[3] + Show full author list

Published 5 August 2020 • © 2020 The Japan Society of Applied Physics

Applied Physics Express, Volume 13, Number 8

Citation Elizabeth Ann Prieto *et al* 2020 *Appl. Phys. Express* **13** 082012

+ Article information

Abstract

A low-temperature-grown GaAs (LTG-GaAs) terahertz (THz) photoconductive antenna device with layer structure consisting of doped buffer demonstrated enhanced emission intensity and detection sensitivity. As THz emitter, a 116% increase is exhibited by the LTG-GaAs with doped buffer relative to its undoped counterpart at 9 V bias and 0.8 mW pump power with spectral distribution extending to ~3 THz. As a THz detector, a dynamic range of 55 dB is obtained at 0.5 THz, which is 5 dB higher than its undoped counterpart. The device proved effective as a THz emitter at low operating bias and pump power while its detection characteristics are acceptable even at low incident THz powers.

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Original Paper

Spray Pyrolysis Deposition of Al-Doped ZnO Thin Films for Potential Picosecond Extreme Ultraviolet Scintillator Applications

Erick John Carlo D. Solibet, Raymund C. Veloz, Melvin John F. Empizo, Horace Andrew F. Husay, Keisuke Kawano, Kohei Yamanoi, Toshihiko Shimizu, Nobuhiko Sarukura, Elmer S. Estacio, Arnel A. Salvador, Armando S. Somintac ... See fewer authors

First published: 18 June 2020 | https://doi.org/10.1002/pssb.201900481

Abstract

For potential extreme ultraviolet (EUV) scintillator applications, aluminum (Al)-doped zinc oxide (ZnO) thin films are successfully fabricated on glass and silicon substrates using spray pyrolysis technique. The Al-doped thin films consist of 160-nm-sized flake-like particles and have 0.30 μm thicknesses and up to 75% visible transmittances. Although Al doping affects the film morphology and optical properties in the visible region, both undoped and Al-doped thin films exhibit hexagonal wurtzite crystal structures and intense 381 nm emissions with 20–30 ps lifetimes. With submicrometer thicknesses and intense picosecond UV emissions, the spray-pyrolysis-deposited Al-doped ZnO thin films have promising potential as ultrafast scintillator materials which may lead to improved imaging and timing of EUV light sources.

Japanese Journal of Applied Physics

RAPID COMMUNICATION

Observation of enhanced terahertz emission in two-dimensional metal line arrays on GaAs surfaces

Hannah Bardolaza[1], Maria Angela Faustino-Lopez[2], Miguel Bacaoco[1], John Paul Ferrolino[2], Ivan Cedrick Verona[1], Victor DC Andres Vistro[1], Neil Irvin Cabello[1], Lorenzo Lopez Jr.[2], Alexander De Los Reyes[1], Armando Somintac[1], Arnel Salvador[1] and Elmer Estacio[1]

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Published 26 June 2020 • © 2020 The Japan Society of Applied Physics

Japanese Journal of Applied Physics, Volume 59, Number 7

Citation Hannah Bardolaza *et al* 2020 *Jpn. J. Appl. Phys.* **59** 070907

+ Article information

Abstract

Enhanced terahertz (THz) emission was observed from semi-insulating GaAs with square and diamond two-dimensional metal line arrays (2DMLA's) of subwavelength periodicity. An externally-applied magnetic field was used to generate elliptically-polarized THz radiation from the samples and the THz emission characteristics were measured using a THz time-domain spectroscopy setup in transmission geometry. Finite difference time-domain simulations verified the enhancement as due to confinement of the THz electric field at the 2DMLA apertures. These results demonstrating spoof plasmonic enhancement effects may be useful for future photoconductive antenna emitter designs incorporating 2D micro-scale integrated optics, THz metamaterials, without the need for expensive electron beam nanolithography.

Applied Surface Science
Volume 511, 1 May 2020, 145590

Full Length Article

True bulk As-antisite defect in GaAs(1 1 0) identified by DFT calculations and probed by STM/STS measurements

Mary Clare Escaño [a], Maria Herminia Balgos [b, d], Tien Quang Nguyen [c], Elizabeth Ann Prieto [d, e], Elmer Estacio [d], Arnel Salvador [d], Armando Somintac [d], Rafael Jaculbia [b], Norihiko Hayazawa [b, d], Yousoo Kim [b, d], Masahiko Tani [a]

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https://doi.org/10.1016/j.apsusc.2020.145590

Highlights

- The third layer As-antisite defect in GaAs(1 1 0) mimics that of bulk GaAs.
- STM image from experiment and theory present a unique asymmetric two-lobe contrast.
- Calculated LDOS and STS spectra reveal three prominent peaks as surface signatures.

Abstract

We reveal the As-antisite (As_{Ga}) defect close to the surface of GaAs(1 1 0) with bulk characteristics using first-principles methods with experimental verifications. We found that the As_{Ga} in the third-layer mimics the geometry, partial charge density and more importantly, the density of states of As_{Ga} in bulk GaAs. Notably, the mid-gap state induced by As_{Ga} in bulk GaAs is well-reproduced by the As_{Ga} in the third layer of GaAs(1 1 0). Simulated and experimental STM images show an "asymmetric two-lobe" feature in the region around the defect. Using local density of states (LDOS) and STS spectra, we propose three prominent peaks with characteristic energy levels corresponding to the third layer As_{Ga}. The above results present the first report of surface electronic signatures of true bulk defect near the surface of GaAs(1 1 0).

Surface Science
Volume 703, January 2021, 121726

Density functional theory-based investigation of hydrogen adsorption on zinc oxide ($10\bar{1}0$) surface: Revisited

Manuel M. Balmeo [a], John Symon C. Dizon [a], Melvin John F. Empizo [b], Erick John Carlo D. Solibet [c], Verdad C. Agulto [b], Arnel A. Salvador [b, c], Nobuhiko Sarukura [b], Hiroshi Nakanishi [d], Hideaki Kasai [d], Allan Abraham B. Padama [a]

https://doi.org/10.1016/j.susc.2020.121726

Highlights

- H atom adsorbed on top of O atom shifts the conduction band below the Fermi level.
- H atom adsorbed on top of Zn atom shifts the valence band upward.
- There is an enhanced H adsorption energy for the full coverage system.
- Low coverages H adsorption were used to explain properties of full coverage system.

Abstract

Density functional theory based calculations with Hubbard correction (DFT + U) were performed to investigate the effects of varying coverage and different adsorption sites on hydrogen (H) adsorption on zinc oxide (ZnO) ($10\bar{1}0$) surface. Results show that H adsorption on top of oxygen (O) at low coverage (0.25 monolayer, ML) shifts the conduction band below the Fermi level and narrows the band gap. These phenomena are attributed to the charge transfer between H and the surface zinc (Zn) and O atoms. On the other hand, the H adsorption on top of Zn at low coverage (0.25 ML) shows an overlapping of H, Zn, and O states while maintaining the semiconductor nature of the system. At high coverage (1.0 ML), a charge accumulation layer on the surface forms, and the mechanisms that govern the interactions of H atoms when adsorbed exclusively on top of Zn or top of O are found to be similar with the low coverage cases. Lastly, at full coverage (2.0 ML), the effect of H on top of Zn is more evident as the system retained its semiconducting property. The adsorption energy is enhanced due to the reinforced overlapping of the H, Zn, and O states and due to the possible attraction between the adsorbed H atoms. The properties and stability of full-coverage adsorption were explained based on the findings on high- and low- coverages adsorption. The findings of the study will aid in understanding the interaction of H with the ZnO surface toward the further development of ZnO's optoelectronic applications.

Article | Open Access | Published: 18 May 2020

An electronic nose using a single graphene FET and machine learning for water, methanol, and ethanol

Takeshi Hayasaka ✉, Albert Lin, Vernalyn C. Copa, Lorenzo P. Lopez Jr., Regine A. Loberternos, Laureen Ida M. Ballesteros, Yoshihiro Kubota, Yumeng Liu, Arnel A. Salvador & Liwei Lin ✉

Microsystems & Nanoengineering **6**, Article number: 50 (2020) | Cite this article

Abstract

The poor gas selectivity problem has been a long-standing issue for miniaturized chemical-resistor gas sensors. The electronic nose (e-nose) was proposed in the 1980s to tackle the selectivity issue, but it required top-down chemical functionalization processes to deposit multiple functional materials. Here, we report a novel gas-sensing scheme using a single graphene field-effect transistor (GFET) and machine learning to realize gas selectivity under particular conditions by combining the unique properties of the GFET and e-nose concept. Instead of using multiple functional materials, the gas-sensing conductivity profiles of a GFET are recorded and decoupled into four distinctive physical properties and projected onto a feature space as 4D output vectors and classified to differentiated target gases by using machine-learning analyses. Our single-GFET approach coupled with trained pattern recognition algorithms was able to classify water, methanol, and ethanol vapors with high accuracy quantitatively when they were tested individually. Furthermore, the gas-sensing patterns of methanol were qualitatively distinguished from those of water vapor in a binary mixture condition, suggesting that the proposed scheme is capable of differentiating a gas from the realistic scenario of an ambient environment with background humidity. As such, this work offers a new class of gas-sensing schemes using a single GFET without multiple functional materials toward miniaturized e-noses.

Springer Link

Research Article | Published: 08 June 2020

Influence of chamber design on the gas sensing performance of graphene field-effect-transistor

Lorenzo Lopez Jr. ✉, Vernalyn Copa, Takeshi Hayasaka, Maria Angela Faustino-Lopez, Yichuan Wu, Huiliang Liu, Yumeng Liu, Elmer Estacio, Armando Somintac, Liwei Lin & Arnel Salvador

SN Applied Sciences **2**, Article number: 1185 (2020) | Cite this article

503 Accesses | Metrics

Abstract

We report on the influence of chamber design on the gas sensing performance of a graphene field-effect-transistor (GFET). A conventional chamber (V = 400 ml) and a cap chamber (V = 1 ml), were used to perform dynamic measurements on a GFET. To gain a-priori knowledge on the gas flow in the chambers, Naiver–Stokes and convection-diffusion equations were numerically-solved using COMSOL Multiphysics. We numerically and experimentally observed two main factors that can affect the GFET performance: (1) the gas flow direction through the chamber and (2) the chamber volume. At 5-min exposure time, at least 200% higher GFET sensitivity was calculated from the cap chamber, which is expected since the conventional chamber is 400 times larger. Interestingly, even when the conventional chamber is fully saturated (at 90-min exposure time), the GFET sensitivity in the cap chamber is still better by 28.57%. We attributed this behavior to the swirling vapor flow in the cap chamber brought about by the U-shaped path. This effect causes multiple interaction of H_2O molecules with the GFET, resulting to higher computed sensitivity. However, at higher relative humidity, the GFET becomes populated, reducing the number of H_2O molecules that can re-interact with the sensor. In terms of GFET transient characteristics, a 154% and 86.9% faster response and recovery, respectively, were observed in the cap-design. This was due to its smaller volume that minimized poorly purged region in the chamber. But if the chambers have the same volumes, we may infer a faster GFET response and recovery from the conventional chamber where the gas flow is unperturbed. These results could contribute in designing a time efficient and cost-effective gas sensing system.

Science Diliman

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Design of a Low-cost Differential Optical Absorption Spectroscopy Set-up for Simultaneous Monitoring of Atmospheric NO2 Concentration and Aerosol Optical Thickness

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Abstract

Air quality monitoring in urban areas is indispensable in understanding the environment and how anthropogenic factors contribute to the increasing volume of pollutants in the atmosphere. Differential optical absorption spectroscopy (DOAS) is a useful technique in identifying and quantifying trace amounts of air pollutants over a wide region. In this paper, a low-cost DOAS set-up was developed and was used to measure nitrogen dioxide (NO_2) concentration and aerosol optical thickness (AOT) in the University of the Philippines Diliman campus. The temporal variation of NO_2 concentration from the DOAS measurement was found to agree with the relative NO_2 integrated absorbance from 430-450 nm. A calibration curve was then constructed with calculated sensitivity of 4.467 per mg•mm-3 (8.540 per ppm). The concentration range of the low-cost set-up is also able to detect unhealthy NO_2 levels in the Philippines. Aerosol optical thickness was then retrieved and showed similar temporal variation with NO_2 throughout the duration of the experiment. The correlation was attributed to the photochemical reaction of NO_2 to NO_3^-, which then forms into aerosol. Average daily AOT at different wavelengths was then determined and was compared to AERONET's data. The results were in agreement with each other and both displayed decreasing AOT at increasing wavelength, which is an expected behavior for a Mie-scattered light due to aerosol. More importantly, proof-of concept demonstration of low-cost DOAS set-up, capable of measuring trace amounts of NO_2 and AOT, was successfully performed. Results show that the low-cost design can provide an alternative, cheaper and portable atmospheric NO_2 and aerosol measurement technique with reliable sensitivity for environmental monitoring applications.

Keywords

nitrogen dioxide (NO2), aerosol, differential optical absorption spectroscopy (DOAS), urban air pollution