Dr. Muhammad Rizwan (HEC Approved Supervisor)

DOB: August 10, 1985
Gender: Male
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Nationality: Pakistani

Career Objectives:

I'm a self motivated and enthusiastic individual with a passionate commitment to my work. Skilled in the design of challenges, enriching and innovative that addresses the diverse interests and needs of an organization. Having good communication skills and an active team member who effectively collaborates with all levels of staff members.

Personal Attributes:

Posses a creative and intellectual personality including regular evaluation of my own effectiveness as a professional. Punctuality, timely and regular completion of tasks has always been important to me; I take pride in these qualities as they to my job satisfaction. I believe I always have something to learn from others who are more experienced and skilled.

PUBLICATIONS:

Year 2013

1- **Muhammad Rizwan**, Yan-Kun Dou, Hai-Bo Jin, Zhi-Ling Hou, Ling-Bao Kong, Jing-Bo Li, Faheem K. Butt and Fida Rehman, "Design of a novel negative refractive index material based on numerical simulation", *Eur. Phys. J. Appl. Phys.* 63 (2013) 10502

2- Muhammad Tahir, Chuanbao Cao, Faheem K. Butt, Faryal Idrees, Nasir Mahmood, Zulfiqar Ali, Imran Aslam, M. Tanveer, **Muhammad Rizwan** and Tariq Mahmood, "Tubular graphitic-C3N4: a prospective material for energy storage and green photocatalysis", *J. Mater. Chem. A*, 01 (2013) 13949

Year 2014

3- **Muhammad Rizwan**, Hai-Bo Jin , Fida Rehman, Zhi-Ling Hou, Jing-Bo Li, Faheem K. Butt, Zulfiqar Ali, "Dual-band tunable negative refractive index metamaterial with F-Shape structure", *Cent. Eur. J. Phys.*, 12 (2014) 578

4- **Muhammad Rizwan,** Hai-Bo Jin, Fida Rehman, Zhi-Ling Hou, Ling-Bao Kong, Jing-Bo Li, Faheem K. Butt, Yan-Kun Dou, Zulfiqar Aliand Muhammad Tahir, "Numerical Study of an A-Shape Negative Refractive Index Material", *Chin. J. Phys.*, 52 (2014) 1521

5- Faryal Idrees, Chuanbao Cao, Faheem K. Butt, Muhammad Tahir, Imran Shakir, **Muhammad Rizwan**, Imran Aslam, M. Tanveer, Zulfiqar Ali, "Synthesis of novel hollow microflowers (NHMF) of Nb3O7F, their optical and hydrogen storage properties", *International Journal of Hydrogen Energy* 39 (2014) 13174

6- Zulfiqar Ali, Sajid Butt, Chuanbao Cao, Faheem K. Butt, Muhammad Tahir, M. Tanveer, Imran Aslam, **Muhammad Rizwan**, Faryal Idrees, and Syed Khalid, "Thermochemically evolved nanoplatelets of bismuth selenide with enhanced thermoelectric figure of merit", *AIP Advances* 4 (2014) 117129

7- Faheem K. Butt, Chuanbao Cao, FaryalIdrees, Muhammad Tahir, Waheed S. Khan, Tariq Mahmood, Muhammad Tanvir, **Muhammad Rizwan**, Zulfiqar Ali, Imran Aslam, Dapeng Yu, Synthesis," Metal-catalyzed synthesis of ultralong tin dioxide nanobelts: Electrical and optical properties with oxygen vacancy-related orange emission", *Materials Science in Semiconductor Processing* 26 (2014) 388

Year 2015

8- Imran Aslam, Chuanbao Cao, M. Tanveer, M. Hassan Farooq, Muhammad Tahir, Syed Khalid, Waheed S. Khan, Faryal Idrees, Muhammad Rizwan and Faheem K. Butt, "A facile one-step fabrication of novel $WO_3/Fe_2(WO_4)_3.10.7H_2O$ porous microplates with remarkable photocatalytic activities", Cryst Eng Comm 26 (2015) 4809

9- Fida Rehman, Jing-BoLi, Mao-Sheng Cao, Yong-Jie Zhao, Muhammad Rizwan, Hai-BoJin " Contribution of grains and grain boundaries to dielectric relaxations and conduction of Aurivillius $Bi4Ti_2Fe_{0.5}Nb_{0.5}O_{12}$ ceramics", Ceramics International 41 (2015) 14652

10- Fida Rehman, Jing-Bo Li, Yan-Kun Dou, Jia-Song Zhang, Yong-Jie Zhao, **Muhammad Rizwan**, Syed Khalid, Hai-Bo Jin, "Dielectric relaxations and electrical properties of Aurivillius $Bi_{3.5}La_{0.5}Ti_2Fe_{0.5}Nb_{0.5}O_{12}$ ceramics", *Journal of Alloys and Compounds* 654 (2015) 315

11- Fida Rehman, Hai-Bo Jin, Jing-Bo Li, Arfan Bukhtiar, Muhammad Khalid, **Muhammad Rizwan**, Saira Riaz, Shahzad Naseem, "Simulations of transient behavior and parasitic effects for 20 nm gate length of PD SOI nMOSFET", *Materials Today* 2 (2015) 5357

Year 2016

12- **Muhammad Rizwan,** Tariq Mahmood, H. M. Rafique, M. Tanvir, Syed Fawad Haider, " Design Of a Negative Refractive Index Material Based on Numerical Simulation", *Chinese Journal of Physics* 54 (2016) 587

13- Zulfiqar Ali, Muhammad Tahir, C. B. Cao, Asif Mahmood, Nasir Mahmood, **Muhammad Rizwan**, Muhammad Tanveer, "Solid Waste for energy storage material as electrode of supercapacitors", *Materials Letters* 181 (2016) 191

Year 2017

14- N.R. Khalid , E. Ahmed, N.A. Niaz, Ghulam Nabi, M. Ahmad, M. Bilal Tahir, Muhammad Rafique, **Muhammad Rizwan**, Yaqoob Khan," Highly visible light responsive metal loaded N/TiO_2nanoparticles for photocatalytic conversion of CO_2 into methane", *Ceramics International* 43 (2017) 6771

15- Saleem M. U; Farman. M; Ahamd, M. O; **Muhammad Rizwan***, "A Control of Artificial Pancreas in Human", *Chinese Journal of Physics* 55 (2017) 2273

16- Tariq Mahmood, Humma Malik, Rahat Batool, Zahida Perveen , Farhat Saleemi, Haris Rasheed, M.A. Saeed, Chuanbao Cao, **Muhammad Rizwan**, "Elastic, electronic and optical properties of anatase TiO 2 under pressure: A DFT approach", *Chinese Journal of Physics* 55 (2017) 1252

17- M. B Tahir, S Hajra, **M Rizwan** and M Rafique, "Pptical, microstructural and electrical studies on sol gel derived TiO_2 thin films", *Indian Journal of Pure and Appied Physics* 55 (2017) 81

Year 2018

18- Ghulam Nabi, Qurat‑ul‑Aain, N. R. Khalid, M. Bilal Tahir, Muhammad Rafique, **Muhammad Rizwan**,Sajad Hussain,Tahir Iqbal,Abdul Majid, "A Review on Novel Eco-Friendly Green Approach to Synthesis TiO_2 Nanoparticles Using Different Extracts", *Journal of Inorganic and Organometallic Polymers and Materials* 28 (2018) 1552

19- Muhammad Umer Saleem, Muhammad Farman, **Muhammad Rizwan***, M.O. Ahmad, Aqeel Ahmad, "Controllability and observability of glucose insulin glucagon system in humans", *Chinese Journal of Physics* 56 (2018) 1909

20- M. Bilal Tahir, S. Hajra, N. R. Khalid, **M. Rizwan,** G. N. Watto, "Development of Sol Gel Derived Nanocrystalline TiO_2 Thin Films via Indigenous Spin Coating Method", *J Inorg Organomet Polym* 28 (2018) 01

21- Abdul Majid, Naeem Ahmad, **Muhammad Rizwan**, Salah-ud-Din Khan, Fekri Abdulraqeb Ahmed Ali, and Jianjun Zhu, "Effects of Mn Ion Implantation on XPS Spectroscopy of GaN Thin Films, *Journal of ELECTRONIC MATERIALS* 47 (2018) 1555

22- **Muhammad Rizwan**, Imran Haider, Tariq Mahmood, Muhammad Shakil, Mahmood ul Hassan, Jin Hai-Bo, Cao Chuan Bao, "First principles investigation of electronic and optical properties of $AgAlO_2$", *Chinese Journal of Physics* 56 (2018) 2186

Year 2019

23- Imran Aslam, M. Hassan Farooq, Usman Ghani, **M. Rizwan**, Ghulam Nabi, Waseem Shahzad,Rajender Boddula, "Synthesis of novel g-C_3N_4 microrods: A metal-free visible-light-driven photocatalyst", *Materials Science for Energy Technologies* 2 (2019) 401

24- **Muhammad Rizwan**, Samina Gul, Tahir Iqbal, Uzma Mushtaq, MHassan Farooq, Muhammad Farman, Rabia Bibi and Mohsin Ijaz, "A review on perovskite lanthanum aluminate ($LaAlO_3$), its properties and applications", *Mater. Res. Express* 6 (2019) 112001

25- M. Hassan Farooq, I. Aslam, Ahmad Shuaib, H. Sadia Anam, **M. Rizwan** and Qudsia Kanwal, "Band gap engineering for improved photocatalytic performance of CuS/TiO_2 composites under solar light irradiation", *Bull. Chem. Soc. Ethiop.* 33 (2019) 561

26- **Muhammad Rizwan**, Rabia Bibi, Tariq Mahmood, Imran Aslam, Syed Sajid Ali Gillani, Hai Boa Jin, Chuan Bao Cao, Zahid Usman, and Ahmad Maqsood, "Band gap modulation effect on electronic and optical properties in $PbTiO_3$ under stress: a DFT study", *Eur. Phys. J. Appl. Phys.* **88** (2019) 10501

27- M. Hassan Farooq, I. Aslam, H. Sadia Anam, M. Tanveer and **M. Rizwan**, "Defect engineering for improved photocatalytic performance of reduced lead titanate ($PbTiO_3$) under solar light irradiation", *Bull. Chem. Soc. Ethiop.* 33 (2019) 373

28- S.S.A. Gillania, Riaz Ahmad, **Muhammad Rizwan***, Muhammad Rafique,Ghulam Ullah, C.B. Cao, H.B. Jin, "Effect of magnesium doping on band gap and optical properties of $SrZrO_3$ perovskite: A first-principles study" *Optik - International Journal for Light and Electron Optics* 191 (2019) 132

29- **Muhammad Rizwan**, Azeem Shahid, Tariq Mahmood, Abrar Ahmad Zafar, Imran Aslam, N. Adnan, Talab Hussain, H.B. Jin, C.B. Cao, "Effect of magnesium on structural and optical properties of $CaTiO_3$: A DFT Study", *Physica B: Condensed Matter* 568 (2019) 88

30- Ameer Maavia, Imran Aslam, M. Tanveer, **M. Rizwan**, M.W. Iqbal, M. Tahir, Habib Hussain, Rajender Boddula, M. Yousuf, "Facile synthesis of g-$C_3N_4/CdWO_4$ with excellent photocatalytic performance for the degradation of Minocycline", *Materials Science for Energy Technologies* 2 (2019) 258

31- **Muhammad Rizwan**, Maida Anwar, Zahid Usman, Muhammad Shakil, S.S.A. Gillani, H.B. Jin, C.B. Cao, Uzma Mushtaq, "Implementation of magnesium doping in $SrTiO_3$ for correlating electronic, structural and optical properties: A DFT study", *Chinese Journal of Physics* 62 (2019) 388

32- Tahir Iqbal, Muhammad Umar Farooq, Mohsin Ijaz, Sumera Afsheen, **Muhammad Rizwan** and Muhammad Bilal Tahir, "Optimization of 1D Silver

Grating Devices for Extraordinary Optical Transmission", *Plasmonics* 14 (2019) 1099

33- S. S. A. Gillani, Riaz Ahmad, I. Zeba, Islah-u-din, **Muhammad Rizwan**, Muhammad Rafique, M. Shakil, Saqib Jabbar and M. Siddique, "Structural stability of $SrZrO_3$ perovskite and improvement in electronic and optical properties by Ca and Ba doping for optoelectronic applications: a DFT approach", *Philosophical Magazine* 99 (2019) 3133

34- **Muhammad Rizwan**, Adnan Ali, Zahid Usman, N.R. Khalid, H.B. Jin, C.B. Cao, "Structural, electronic and optical properties of copper-doped $SrTiO_3$ perovskite: A DFT study", *Physica B: Condensed Matter* 552 (2019) 52

35- M. Shakil, Sharjeel Hassan, Hafsa Arshad, **M. Rizwan**, S.S.A. Gillani, M. Rafique, M. Zafar, Shabbir Ahmed, "Theoretical investigation of structural, magnetic and elastic properties of half Heusler LiCrZ (Z ¼ P, As, Bi, Sb) alloys", *Physica B: Condensed Matter* 575 (2019) 411677

36- Hafsa Arshad, M. Zafar, S. Ahmad, **M. Rizwan**, M. I. Khan, S. S. A. Gillani, Chuan Bao Cao and M. Shakil, "Theoretical study of structural, electronic and magnetic properties of equiatomic quaternary CoPdCrZ (Z = Si, Ge, P) Heusler alloys", *Modern Physics Letters B* 33 (2019) 1950389

37- M. Zafar, M. Kashif Masood, **M. Rizwan**, Anam Zia, Shabbir Ahmad, Arfan Akram, Cao Chuan Bao, M. Shakil, "Theoretical study of structural, electronic, optical and elastic properties of $Al_xGa_{1-x}P$", *Optik - International Journal for Light and Electron Optics* 182 (2019) 1176

Year 2020

38- **Muhammad Rizwan**, S. Aleena, M. Shakil, Tariq Mahmood, Abrar Ahmad Zafar, Talab Hussain, M.H. Farooq, "A computational insight of electronic and optical properties of Cd doped $BaZrO_3$", *Chinese Journal of Physics* 66 (2020) 318

39- Muhammad Farman, Aqeel Ahmad, Ali Akgül, Muhammad Umer Saleem, **Muhammad Rizwan**, Muhammad Ozair Ahmad, "A mathematical analysis and simulation for Zika virus model with time fractional derivative", (2020) https://doi.org/10.1002/mma.6891

40- Ghulam Nabi, Khalid Nadeem Riaz, Maria Nazir, Waseem Raza, Muhammad Bilal Tahir, Muhammad Rafique, Nafisa Malik, Ayesha Siddiqa, S. Sajid Ali Gillani, **Muhammad Rizwan**, Muhammad Shakil, Muhammad Tanveer, "Cogent synergic effect of TiS_2/g-C_3N_4 composite with enhanced electrochemical performance for supercapacitor", *Ceramics International* 46 (2020) 27601

41- I zeba, N bashir, Riaz Ahmad, M shakil, M **Rizwan**, M Rafique, Farzana Rashid and S S A Gillani, "Cubic to pseudo-cubic tetragonal phase transformation with

lithium and beryllium doping in $CaTiO_3$ and its impact on electronic and optical properties: a DFT approach", *Bull Mater Sci* 43 (2020) 244

42- I. Zeba, R. Jabeen, Riaz Ahmad, M. Shakil, M. Rafique, **M. Rizwan**, N. Bashir, S. S. A. Gillani, "Effect of anomalous behavior of Be‑doping on structural stability, bandgap and optical properties in comparison with Mg‑doped $BaZrO_3$ perovskite: insights from DFT calculations", *Optical and Quantum Electronics* 52 (2020) 234

43- S.S.A. Gillani, Riaz Ahmad, I. Zeba, Islah-u-din, M. Shakil, **Muhammad Rizwan**, Muhammad Rafique, M. Sarfraz, S.S. Hassan, "Effect of external pressure on the structural stability, electronic structure, band gap engineering and optical properties of LiNbO3: An ab-initio calculation", *Materials Today Communications* 23 (2020) 100919

44- **Muhammad Rizwan**, Zahid Usman, Muhammad Shakil, S SAGillani, S Azeem,HB Jin, CB Cao, Rana Farhat Mehmood, Ghulam Nabi and Muhammad Adnan Asghar, "Electronic and optical behaviour of lanthanum doped $CaTiO_3$ perovskite", *Mater. Res. Express* 7 (2020) 015920

45- **Muhammad Rizwan**, Hajra, I. Zeba, Muhammad Shakil, S.S.A. Gillani, Zahid Usman, "Electronic, structural and optical properties of $BaTiO_3$ doped with lanthanum (La): Insight from DFT calculation" *Optik - International Journal for Light and Electron Optics* 211 (2020) 164611

46- M. Shakil, Hafsa Arshad, M. Zafar, **M. Rizwan**, S. S. A. Gillani and Shabbir Ahmed, "First-principles computation of new series of quaternary Heusler alloys CoScCrZ (Z = Al, Ga, Ge, In): a study of structural, magnetic, elastic and thermal response for spintronic devices", *Molecular Physics* 118 (2020) 1789770

47- I. Zeba, M. Ramzan, Riaz Ahmad, M. Shakil, **M. Rizwan**, M. Rafique, M. Sarfraz, M. Ajmal, S.S.A. Gillani, "First-principles computation of magnesium doped $CaZrO_3$ perovskite: A study of phase transformation, bandgap engineering and optical response for optoelectronic applications", *Solid State Communications* 313 (2020) 113907

48- S.S.A. Gillani, Riaz Ahmad, Islah-u-din, **Muhammad Rizwan**, M. Shakil, Muhammad Rafique, G. Murtaza, H.B. Jin, "First-principles investigation of structural, electronic, optical and thermal properties of Zinc doped $SrTiO_3$", *Optik - International Journal for Light and Electron Optics* 201 (2020) 163481

49- **Muhammad Rizwan**, A. Khadija, I. Zeba, M. Shakil, Zahid Usman, S. S. A. Gillani, "First‑principles investigation of structural modification, fine band gap engineering, and optical response of $La_{1-x}Ba_xGaO_3$ for optoelectronic applications" *Applied Physics A* 126 (2020) 688

50- Ghulam Nabi, Qurat-Ul- Ain, M. Bilal Tahir, Khalid Nadeem Riaz, Tahir Iqbal, Muhammad Rafique, Sajad Hussain, Waseem Raza, Imran Aslam and **Muhammad Rizwan, "**Green synthesis of TiO_2 nanoparticles using lemon peel

extract: their optical and photocatalytic properties", *International Journal of Environmental Analytical Chemistry* (2020) https://doi.org/10.1080/03067319.2020.1722816

51- Muhammad Isa Khan, Hafsa Arshad, **M. Rizwan**, S.S.A. Gillani, M. Zafar, Shabbir Ahmed, M. Shakil, "Investigation of structural, electronic, magnetic and mechanical properties of a new series of equiatomic quaternary Heusler alloys CoYCrZ (Z ¼ Si, Ge, Ga, Al): A DFT study", *Journal of Alloys and Compounds* 819 (2020) 152964

52- **Muhammad Rizwan**, S Anam, Muhammad Farman, Ali Akgul and M Uzma "Role of Zn in modification of electronic and optical properties of c-$SrZrO_3$: a computational insight", *Phys. Scr.* 95 (2020) 085212

53- Ghulam Nabi, Salsbeel Rehman, Muhammad Bilal Tahir, Nafisa Malik, Raheel Yousaf, Mudassar Maraj, **Muhammad Rizwan** and Muhammad Tanveer, "Structural, Optical, and Magnetic Properties of Pure and Vanadium-Doped NiO Microstructures for Spintronics Applications" *Journal of Superconductivity and Novel Magnetism* (2020) https://doi.org/10.1007/s10948-020-05736-3

54- M. Zafar, Halima Sadia, **M. Rizwan**, Hafsa Arshad, Shabbir Ahmad, S.S.A. Gillani, Islah-u-din, Cao Chuan Bao, Xiao-Ping Wei, M. Shakil, "Theoretical study of the structural, electronic and magnetic properties of equiatomic quaternary CoTcCrZ (Z = Si, Ge, P) Heusler alloys", *Chinese Journal of Physics* 64 (2020) 123

Year 2021

55- **Muhammad Rizwan**, Z. Khadija, Tariq Mahmood, S.S.A. Gillani, Muhammad Isa Khan, "Alteration impact of electronic properties of c-$SrTiO_3$ on optical response due to Ca inclusion: A DFT study", *Physica B: Condensed Matter* 602 (2021) 412553

56- **M. Rizwan,** I. Iqra, S. S. A. Gillani, I. Zeba, M. Shakil, and Z. Usman, "First-Principles Investigation of Structural, Electronic, and Optical Response of SnZrO3 with Al Inclusion for Optoelectronic Applications", *Physics of the Solid State* 63 (2021) 134

57- Ghulam Nabi, Nafisa Malik, M. Bilal Tahir, Waseem Raza, **Muhammad Rizwan**, Mudassar Maraj, Ayesha Siddiqa, Rizwan Ahmed, Muhammad Tanveer, "Synthesis of graphitic carbon nitride and industrial applications as tensile strength reinforcement agent in red Acrylonitrile-Butadiene-Styrene (ABS)", *Physica B: Condensed Matter* 602 (2021) 412556

58- **Muhammad Rizwan**, Asma Ayub, M. Shakil, Zahid Usman, S.S.A. Gillani, H.B. Jin, C. B. Cao, "Putting DFT to trial: For the exploration to correlate structural, electronic and optical properties of M-doped (M = Group I, II, III, XII, XVI) lead free high piezoelectric c-$BiAlO_3$", *Materials Science and Engineering B* 264 (2021) 114959

59- M Shakil, M Kousar, S S A Gillani, **M Rizwan**, H Arshad, M Rafique and M Zafar, "First principle computation of half metallicity and mechanical properties of a new series of half Heusler alloys KMnZ (Z = B, Si, Ge, As) for spintronics", *Indian J Phys* (2021) https://doi.org/10.1007/s12648-020-01967-1

60- M. Rizwan, S. Gul, T. Mahmood, M. Shakil, A. Majid, M. Rafique, A.A. Zafar, H.B. Jin, and C.B. Cao, "Tailoring electronic and optical properties of $LaAlO_3$ by Cu inclusion: a DFT study", *Canadian Journal of Physics* (2021) https://doi.org/10.1139/cjp-2019-0558

61- Muhammad Rizwan, Hira Hameed, Uzma Mushtaq, M. Isa Khan, S. S . A. Gillani, M.H. Farooq, "Correlation between electronic and optical responses of intrinsic and Cd-doped c-$SrHfO_3$: A computational insight", *Physica B: Condensed Matter* (2021) https://doi.org/10.1016/j.physb.2020.412493

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Books/ Book Chapters

1- **Book Title:** Reference Module in Materials Science and Materials Engineering
Chapter Title: Hydrogen Evolution Using Advanced Technologies Based on Photocatalysis and Plasma
Publisher: Elsevier Inc.
Year: 2019

2- **Book Title:** Nanotechnology and Photocatalysis for Environmental Applications
Chapter Title: Photocatalytic nanomaterials for degradation of organic pollutants and heavy metals
Publisher: Elsevier Inc.
Year: 2020

3- **Book Title:** Materials for Solar Cell Technologies I
Chapter Title: Monocrystalline Silicon Solar Cells
Publisher: Materials Research Forum LLC
Year: 2021

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EDUCATION:

2011- 2015 **PhD Materials Physics and Chemistry**
Department of Materials Science
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2008-2011 **M.Phil/MS in Physics**
Department of Physics,
Government College University, Lahore, Pakistan

2006-2008 **Masters Of Science (Computational Physics)**
Center for High Energy Physics, University of the Punjab, Lahore, Pakistan

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PROFESSIONAL EXPERIENCE:

- Assistant Professor (TTS) of Physics at School of Physical Sciences, University of The Punjab (PU), Lahore, Pakistan.
- Assistant Professor (TTS) of Physics at Department of Physics, University of Gujrat, Gujrat, Pakistan.
- Assistant Professor (IPFP) of Physics at Department of Physics, University of the Punjab, Lahore, Pakistan.
- Lecturer of Physics and head of Physics Department at Pakistan Embassy College Beijing P. R. China.
- Lecturer at Minhaj International University, Lahore, Pakistan.
- Visiting Lecturer of Physics at Department of Physics, Division of Science and Technology, University of Education, Lahore, Pakistan.

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COMPUTER COMPETENCY:

- CST Microwave Studio
- Materials Studio
- Origin
- Mathematica.
- Borland C++

AWARDS:

- Distinguished student of the year 2013-2014.
- Distinguished student of the year 2012-2013.
- Best international student of the year 2012-2013.
- Won CSC scholarship for 2011-2015.