

Dr. Anuj Kumar

"Associate Professor"

Department of Physics

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Area of Interest

- Semiconductor Materials: Processing and Devices.
- Organic Semiconductor Materials and Devices.
- Thin Films Deposition and Characterization Technology.
- Low-cost, Earth-abundant Materials for Solar Cells.
- Transparent Conducting Oxides and Self-cleaning Window Technology.
- Dye-Sensitized Photo-electrosynthesis and Perovskite based Solar Cell technology.
- MEMS/NEMS technology.
- Solid State Electronic Device Modeling and Device Physics.
- Integrated Circuit (Ic) Interconnection Technology.
- Vacuum Science and Technology.
- Vedic Physics and Ancient Indian Science and Technology.

Education

- **Ph.D.** Electronic Science (March 2011)
Electronic Science Department, Kurukshetra University Kurukshetra, India
Dissertation: "Thin Film Deposition of Ni based Alloys by Electroless Technique for Diffusion Barrier Layers in Integrated Circuits"
 - **Master of Science** (Physics)
Gurukula Kangri Vishwavidyalaya Haridwar, India (Year of passing: 2004)
 - **Bachelor of Science** (Physics, Chemistry, Mathematics)
C. C. S. University Meerut, India (Year of passing: 2002)
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Experience:

- April 2021 Continue: Associate Professor
Department of Physics J. C. Bose University of Science and Technology, YMCA,
Faridabad, Haryana, India
- August 2018 to April 2021: Associate Professor
Department of Physics Starex University, Gurugram, Haryana, India
- March 2018 to July 2018: Research Scientist

- Center for Energy Studies, IIT Delhi India
- March 2015 to March 2018: DST Young Scientist (Photovoltaic lab)
Center for Energy Studies, IIT Delhi India
 - April 2011 to Feb. 2015: Project Scientist (Photovoltaic lab)
Center for Energy Studies, IIT Delhi India
 - September, 2010 to March 2011: Guest faculty in Department of Physics, University College, Kurukshetra University Kurukshetra
 - August, 2006 to March 2011: Research Scholar (VLSI Fabrication)
Electronic Science Department Kurukshetra University Kurukshetra, India
 - June, 2005 to July, 2006: Project Fellow Electron tube Group Area
Central Electronics Engineering Research Institute, Pilani, Rajasthan India
 - August, 2004 to May, 2005: Lecturer in Department of Physics
J.V. College Barout, Bagpat under the CCS University Meerut, India
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Fellowship awarded

- Fast track DST Young Scientist Fellowship (may 2014)
 - NRF Postdoctoral Fellowship in school of Physics Witwatersrand University, Johannesburg, S.A. (13 June 2013)
 - URS (University Research Fellowship during PhD. Kurukshetra University Kurukshetra 2009-2010)
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Research Projects (As a PI)

- “Design and fabrication of PZT based energy harvesting generator by low-cost chemical technique
Sponsored Agency: Haryana State Council for Science Innovation and Technology Haryana, Govt. of India (**Status: Ongoing**)
Fabrication of $\text{Cu}_2\text{ZnSnS}_4$ (CZTS) based solar cell by sol-gel spin coating (**Status: Ongoing**)
Sponsored Agency: J. C. Bose University of Science and Technology, YMCA, Faridabad
- Passivation Technology Development for Improving the Efficiency of Solar Cells (**Status: Ongoing**)
Sponsored Agency: J. C. Bose University of Science and Technology, YMCA, Faridabad
- Electro Spray based TiO_2 / Graphene Nano composite for the enhancement of Incident photon to current conversion efficiency (IPCE) of dye-sensitized (DSSC) solar cell. (**Status: Completed**)
Sponsored Agency: Department of Science & Technology (DST), New Delhi, Govt. of India)

Research Projects (As a Member)

- ESCORT (Efficient Solar Cells based on Organic and hybrid Technology) (**Status: Completed**)
Sponsored Agency: Department of Science & Technology (DST), New Delhi, Govt. of India)
 - APEX (Advancing the efficiency and production potential of excitonic solar cells) (**Status: Completed**) Sponsored Agency: Department of Science & Technology (DST), New Delhi, Govt. of India)
 - PIHJ (Development of large area, high efficiency (19%) Passivated Interface Heterojunction Solar Cells) (**Status: Completed**) Sponsored Agency: Department of Science & Technology (DST), New Delhi, Govt. of India)
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Microelectronics processing and characterization Skills

- Wafer cleaning processes: Ultrasonic, Piranha, RCA (SC1 & SC2), Rinse & dryer.
 - Oxidation, Diffusion processes.
 - Thin Film Deposition by Evaporation, DC/RF Sputtering, Electroless, Electroplating, Sol-Gel spin coating spray pyrolysis and PECVD.
 - Photolithography, single & double side.
 - Wet Isotropic and Anisotropic Etching processes.
 - MOS/MIS, FET, pn junction, schottky diode, heterostructure pn junction diode, Porous Silicon, transition metal oxide based devices fabrication and characterization.
 - Thin Film Thickness measurement (Stylus Profiler, ellipsometer).
 - Charge transport (I-V, C-V, G-V) characterization by Keithley System, characterization of semiconductor by Hall effect, Cyclic Voltammetry, Impedance spectroscopy, UV/VIS, P.L. spectrometer and Raman spectroscopy, surface characterization by AFM, SEM, elemental and phase characterization by AES, EDX, XPS and XRD.
 - Design and maintenance of vacuum systems.
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List of Publications

In Journals:

1. **Anuj Kumar**, Amanpal Singh, Dinesh Kumar, Ashish Garg, Viresh Dutta, Sanjay Kumar Swami, Neha Chaturvedi, Manoj Kumar, “Spray deposited carbon nanotube embedded ZnO as an electrons transport layer in inverted organic solar cells”, Hybrid Advances, 4, , (2023) 100088.
2. Vandana Kaushik, Manoj Kumar and **Anuj Kumar**, Structural and Optical Properties of BaTiO₃ “Thin Film Deposited on Quartz Substrate by Sol Gel Technique”, Eur. Chem. Bull. 2023, 12 (Special Issue 1), 2304-2313, ISSN: 2063-5346

3. Sanjay Kumar Swami, Bidyut Barman, **Anuj Kumar**, Viresh Dutta “Multilayer and Thin Transparent Conducting Oxide Fabrication Using RF Magnetron Sputtering on Flexible Substrates” *Organic Materials* 5, (2023), 59–65 :ISSN: **2625-1825**
4. Amanpal Singh, Yogesh Kumar Saini, **Anuj Kumar**, Sanjeev Gautam, Dinesh Kumar, Viresh Dutta, Han-koo Lee, Jongsu Lee, and Sanjay Kumar Swami “Property Modulation of Graphene Oxide Incorporated with TiO₂ for Dye-Sensitized Solar Cells” *ACS Omega* 7, (2022), 44170–44179 **I.F. 4.1, ISSN: 2470-1343**
5. Sanjay Kumar Swami, Neha Chaturvedi, **Anuj Kumar**, Vinod Kumar, Ashish Garg, Viresh Dutta “Spray deposited gallium doped zinc oxide (GZO) thin film as the electron transport layer in inverted organic solar cells” *Solar Energy* 231 (2022) 458–463, **I.F. 5.7, ISSN: 0038-092X**
6. Sanjay Kumar Swami, N. Chaturvedi, **Anuj Kumar** and V. Dutta “Effect of zinc precursor on Cu₂ZnSnS₄ nanoparticles synthesized by the solvothermal method and its application in dye-sensitized solar cells as the counter electrode” for improved performance” *Materials Today Energy*, 9, (2018), 377-382 (**I.F. 5.6**) **ISSN: 2468-6069**
7. Sanjay Kumar Swami, N. Chaturvedi, **Anuj Kumar** and V. Dutta “Dye sensitized solar cells using the electric field assisted spray deposited kesterite (Cu₂ZnSnS₄) films as the counter electrodes for improved performance” *Electrochimica Acta*, , 263, (2018), 26-33 (**I.F. 6.2**), **ISSN: 0013-4686**
8. Vinod Kumar, Sanjay Kumar Swami, **Anuj Kumar**, O.M. Ntwaeaborwa, Viresh Dutta, H.C. Swart, “Eu³⁺ doped down shifting TiO₂ layer for efficient dye-sensitized solar cells”, *Journal of Colloid and Interface Science* 484 (2016) 24–32. **I.F. 7.4, ISSN: 0021-9797**
9. Sanjay Kumar Swami, N. Chaturvedi, **Anuj Kumar** and V. Dutta, Effect of deposition temperature on the morphological and electrical properties of spray deposited kesterite (Cu₂ZnSnS₄) films, *Solar Energy* 122 (2015) 508–516, **I.F. 4.6, ISSN: 0038-092X**
10. Sanjay Kumar Swami, Neha Chaturvedi, **Anuj Kumar**, Viresh Dutta, “The effect of electric field on spray deposited indium doped zinc oxide films”, *Journal of Progress in Photovoltaic: Research and Applications* 24 (2016) 74–82. **I.F. = 7.58, ISSN: 1099-159X**
11. Sanjay Kumar Swami, Neha Chaturvedi, **Anuj Kumar**, Raman Kapoor, Viresh Dutta, Julien Frey, Thomas Moehl, Michael Grätzel, Simon Mathew, Mohammad Khaja Nazeeruddin “Investigation of electrodeposited cobalt sulphide counter electrodes and their application in next-generation dye sensitized solar cells featuring organic dyes and cobalt-based redox electrolytes” *Journal of Power Sources* 275 (2015) 80-89. **I.F. = 8.2, ISSN: 0378-7753**
12. Sanjay Kumar Swami, Neha Chaturvedi, **Anuj Kumar**, Nikhil Chander, Viresh Dutta, D. Kishore Kumar, A. Ivaturi, S. Senthilarasu and Hari M. Upadhyaya, “Spray deposited copper zinc tin sulphide (Cu₂ZnSnS₄) film as a counter electrode in dye sensitized solar cells” *Physical Chemistry Chemical Physics*, 16 (2014), 23993-23999 **I.F. = 4.20, ISSN 1463-9084**, citation=1

13. **Anuj Kumar**, Ashok Suhag, Amanpal Singh, Satinder K.Sharma, Mukesh Kumar, Dinesh Kumar “Deposition and characterization of electroless Ni-Co-P alloy thin film for ULSI application” *Materials Research Express* 1 (2014) 035007, **I.F. = 1.5, ISSN: 2053-1591**
14. Neha Chaturvedi, Sanjay Kumar Swami, **Anuj Kumar**, and Viresh Dutta, “Role of ZnO nanostructured layer spray deposited under electric field in stability of Inverted Organic Solar Cell” *Solar Energy Materials and Solar Cells*, 126 (2014) 74–82. **I.F. = 6.9, citation= 2, ISSN: 0927-0248.**
15. **Anuj Kumar**, Sanjay Kumar Swami, and Viresh Dutta “The role of electric field during spary deposition on fluorine doped tin oxide” *Journal of Alloys and Compounds*, 588 (2014) 546–550. **I.F. = 4.6, citation = 3, ISSN: 0925-8388.**
16. Satinder K. Sharma, Sumit Barthwal, Vikram Singh, **Anuj Kumar**, Prabhat K. Dwivedi, B. Prasad, Dinesh Kumar “PECVD based Silicon Oxynitride Thin Films for Nano Photonic On Chip Interconnects Applications” *Micron* 44 (2013) 339–346. **I.F. = 2.06, citation= 1, ISSN: 0968-4328.**
17. **Anuj Kumar**, Mukesh Kumar, and Dinesh Kumar “Effect of composition on electroless deposited Ni-Co-P alloy thin films as a diffusion barrier for copper metallization” *Applied Surface Science* 258 (2012) 7962–7967. **I.F. = 6.1, citation = 12, ISSN: 0169-4332.**
18. Amanpal Singh, Dinesh Kumar, P.K. Khanna, **Anuj Kumar**, Mukesh Kumar, Mohit Kumar “Anomalous behavior in ZnMgO thin films deposited by sol–gel method” *Thin Solid Films* 519 (2011) 5826–5830. **I.F. = 2.13, citation= 13, ISSN: 0040-6090.**
19. **Anuj Kumar**, Amanpal Singh, Mukesh Kumar, Dinesh Kumar, Sumit Barthwal “Study on thermal stability of electroless deposited Ni-Co-P alloy thin film” *Journal of Materials Science: Materials in Electronics*, 22 (2011) 1495-1500. **I.F.= 1.97, citation=5, ISSN: 0957-4522.**
20. **A. Kumar**, A. Singh, R. Kumar, M. Kumar, D. Kumar “Reactively sputtered amorphous MoN film as a diffusion barrier for copper metallization” *Optoelectronics and Advanced Materials – Rapid Communications*, 5, (2011) 54-57. **I.F.= 0.5, ISSN: 1842-6573.**
21. Amanpal Singh, D. Kumar, P. K. Khana, **Anuj Kumar**, and Mukesh Kumar “Dielectric Anomaly in Mg Doped ZnO Thin Film Deposited by Sol–Gel Method” *Journal of the Electrochemical Society*, 158 (1) G9-G12 (2011). **I.F. = 3.7, ISSN: 0013-4651.**
22. **Anuj Kumar**, Mukesh Kumar, Amanpal Singh, Satinder Kumar, Dinesh Kumar “Nickel Silicide formation by Electroless technique for ULSI technology” *Microelectronic Engineering* 87 (2010) 286–289. **I.F. = 1.34, citation=4, ISSN: 0167-9317.**
23. **Anuj Kumar**, Mukesh Kumar, and Dinesh Kumar “Deposition and characterization of electroless Ni-Co-P alloy for diffusion barrier applications” *Microelectronic Engineering* 87 (2010) 387–390. **I.F. = 2.3, citation=12, ISSN: 0167-9317.**

24. A. Singh, **A. Kumar**, N. Suri, S. Kumar, M. Kumar, P. K. Khanna, D. Kumar “Structural and optical characterization of ZnO thin films deposited by sol-gel method” Journal of Optoelectronics and Advanced Materials, 11 (2009) 790-793. **I.F. = 0.5, citation=8, ISSN: 14544164.**

In International Conferences:

1. "Electric Field Assisted Spray Deposited Indium Doped Zinc Oxide Nano Structure TCO Thin Film for Self-Cleaning Window and Electron Transport Layer for Inverted Organic Solar Cell Application " **Anuj Kumar**, International Conference on Hybrid and Organic Photovoltaics , held from 28th June to 1st July 2016, in Swansea, UK.
2. “Effect of electric field on spray deposited kesterite (Cu₂ZnSnS₄) film” Sanjay Kumar Swami, Neha Chaturvedi, **Anuj Kumar**, Vamsi K. Komarala, Viresh Dutta 29th European Photovoltaic Solar Energy Conference and Exhibition, At Amsterdam, (2014)Volume: Page 1798-1800
3. “Mesoporous TiO₂ Microsphere Synthesized by Continuous Spray Pyrolysis for Perovskite Solar Cells” Sanjay Kumar Swami, Neha Chaturvedi, **Anuj Kumar**, Charu Dwivedi, Viresh Dutta 6 th Hybrid Organic Photovoltaic Conference - Lausanne 2014, Lausanne Switzerland; 05/2014
4. “Deposition of kesterite Cu₂ZnSnS₄ (CZTS) thin films by sol-gel spin coating technique for the solar cell application” Sanjay Kumar Swami, **Anuj Kumar**, Viresh Dutta Energy Procedia 33 (2013) 198 – 202, PV Asia Pacific Conference 2012. Citation=6, ISSN: 1876-6102.

In national Conferences:

1. “Synthesis of nano-crystalline ZnO thin film by Sol-Gel technique” Amanpal Singh, **Anuj Kumar**, Satinder Kumar, Mukesh Kumar, P.K. Khanna and Dinesh Kumar National conference on semiconductor materials and technology at Gurukula Kangri Vishwavidyalaya Haridwar India,16-18 October 2008.
2. “Deposition and characterization of electroless Ni-Co-P alloy thin film”**Anuj Kumar**, Amanpal Singh, S. Kumar, Mukesh Kumar, B. Prasad and D. Kumar National conference on semiconductor materials and technology at Gurukula Kangri Vishwavidyalaya Haridwar India,16-18 October 2008.
3. “The evolution of phase transformation during annealing of electroless Ni-Co-P alloy thin film” **Anuj Kumar**, Amanpal Singh, Satinder Kumar, Mukesh Kumar, B. Prasad and Dinesh Kumar, National Conference on Photonics & Material Science, Guru Jambheshwer University, Hisar, Haryana, India, October 24-25, 2008
4. “Synthesis of ZnO thin film by Sol-Gel method and its characterization” Amanpal Singh, **Anuj Kumar**, Mukesh Kumar, P.K. Khanna and D. Kumar Ist Rashtreeya Yuva Vaigyanik Sammelan organized by National Institute of Technology, Kurukshetra, Haryana, India, 28-30 November, 2008
5. “Raman study on NiSi formation by Electroless for ULSI technology” **Anuj Kumar**, Mukesh Kumar, Amanpal Singh, B. Parsad and D. Kumar Ist Rashtreeya Yuva Vaigyanik Sammelan organized by National Institute of Technology, Kurukshetra, Haryana, India, 28-30 November, 2008

6. "Effect of annealing temperature on dielectric constant of ZnMgO thin film deposited by Sol-Gel method" Amanpal Singh, **Anuj Kumar**, Mukesh Kumar, P.K. Khanna and D. Kumar 53rd DAE Solid State Physics Symposium at Bhabha Atomic Research Centre, Mumbai December 16-20, 2008.
 7. "Study on electroless deposited Nickel alloy for ULSI application" Dinesh Kumar, Mukesh Kumar, **Anuj Kumar** 97th Indian Science Congress Conference, Thiruvananthapuram, Kerala, India, 3-7 January 2010
 8. "Amorphous MoN films as a diffusion barrier for copper metallization" Dinesh Kumar, **Anuj Kumar**, Mukesh Kumar 98th Indian Science Congress Conference SRM University Chennai , India, 3-7 January 2011
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