Ritwik Nag

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EDUCATION

Ph.D., Department of Electrical Engineering — Expected May 2026
University of South Carolina, Columbia, USA — Advisor: Prof. Krishna C. Mandal
Device Engineering and Defect Characterization of Wide-Bandgap Semiconductor Detectors

M.S., Department of Electrical Engineering — May 2022
University of South Carolina, Columbia, USA
Growth, characterization and evaluation of CdZnTeSe single crystals for room temperature radiation detectors

RESEARCH EXPERIENCE

Graduate Research Assistant (Ph.D.) — August 2022 - Present
Department of Electrical Engineering, University of South Carolina | Columbia, SC 29208, USA

- Growth of crystals using Bridgman and gradient freeze methods. Device fabrication using DC sputtering and surface passivation techniques using chemo-mechanical and growing high-k dielectric layers.
- Experience with device characterizations techniques such as I-V, C-V, SEM-EDX, XPS, and XRD.
- Defect characterization and analysis using deep level transient spectroscopy (DLTS), current transient spectroscopy (CTS) and photo-induced current transient spectroscopy (PICTS) from low (84K) to high temperature (800K).
- Perform data analysis and device modeling using: OriginLab, LTSpice, MATLAB, 1D Poisson Solver, Ansys HFSS, Synopsis Sentaurus, and R-Studio.
- Radiation detection using alpha, beta and gamma sources on fabricated semiconductor devices for testing room temperature and harsh environment applications.

Graduate Research Assistant (M.S.) — Jan 2021 – May 2022
University of South Carolina | Columbia, SC, USA

- Developed and implemented a modified vertical Bridgman method for growing semiconductor single crystals, utilizing in-house zone-refined 7 N purity elemental precursors resulting in enhanced crystal quality.
- Fabricated radiation detectors in planar geometry on CdZnTeSe (CZTS) single crystals using DC Sputtering.
- Crystal characterization using energy-dispersive X-ray (EDX) analysis and powder X-ray diffraction (XRD) ensuring material consistency and reliability.
- Achieved superior charge transport properties in CZTS single crystals by growing detector-grade crystals using the vertical gradient freeze (VGF) method.
- Demonstrated the growth of CZTS single crystals with desired stoichiometry for high resolution radiation detection, laying the groundwork for further advancements in CZTS-based gamma-ray detector technology.

TEACHING EXPERIENCE

Graduate Instructional Assistant Aug 2022 – Dec 2023
University of South Carolina | Columbia, SC 29208, USA

- Instructed lab sessions for ELCT 201 (Sophomore): Introduction to Electrical Circuits, impacting about 200 undergraduate students.
- Developed and implemented lab frameworks, improving student engagement.

Grader/Teaching Assistant Jan 2024 – May 2025
University of South Carolina | Columbia, SC 29208, USA

- ELCT 363: Introduction to Microelectronics (Undergraduate Course)
- ELCT 510: Photovoltaics Materials and Devices (Undergraduate and Graduate students combined course)

HONORS, AWARDS, GRANTS & SCHOLARSHIPS

SPARC Graduate Research Grant, Office of Vice President (VP) Research, USC, 2024: High-resolution brain imaging system based on multi-pixel CdZnTeSe detector.

Travel Grant, Graduate School, University of South Carolina, 2024.

Best Student Poster Award, IEEE-NSS/MIC/RTSD, Tampa, Florida, USA, 11/2/ 2024.

SERVICE ACTIVITIES

Lab Safety Officer, Photovoltaics and Radiation Detectors (PANRAD) Lab, USC, Columbia. 2021 – Present

- Maintenance of research laboratories and training new research students in lab safety protocols.
- Keeping up compliance with Environment, Health, and Safety (EHS) regulations and helping conduct monthly, quarterly and annual lab safety checks with USC and EHS.

IEEE Graduate Student Member 2021 - Present

Journal Reviewer 2022 – Present

- Energy Reports, Elsevier
- Microelectronics, Elsevier
- Nuclear Engineering and Technology, Elsevier
- Nuclear Instruments & Methods in Physics Research, Elsevier

JOURNAL PUBLICATIONS

1. **Nag, Ritwik**; Oner, Cihan; Chaudhuri, Sandeep K; Mandal, Krishna C; "*Investigating 4H-SiC epilayer thickness variation in high-resolution Ni/Y_2O_3/4H-SiC MOS detectors,"* **Journal of Materials Science: Materials in Electronics, 36**, 34, 2172, 2025, DOI: https://doi.org/10.1007/s10854-025-16272-y
2. **Nag, Ritwik**; Chaudhuri, Sandeep K; Ruddy, Frank H; Mandal, Krishna C; "*High-*

Resolution Cr/4H-SiC Schottky Barrier Radiation Detector," **IEEE Transactions on Nuclear Science**, **72**, 4, 1644-1651, 2025, DOI: 10.1109/TNS.2025.3547998

3. **Nag, Ritwik**; Chaudhuri, Sandeep K; Kleppinger, Joshua W; Karadavut, OmerFaruk; Mandal, Krishna C.; "*Vertical gradient freeze growth of detector grade CdZnTeSe single crystals,*" **Journal of Crystal Growth**, **596**, 126826-1-7, 2022, DOI: https://doi.org/10.1016/j.jcrysgro.2022.126826

4. **Nag, Ritwik**; Chaudhuri, Sandeep K; Kleppinger, Joshua W; Karadavut, OmerFaruk; Mandal, Krishna C; "*Characterization of vertical Bridgman grown* $Cd_{0.9}Zn_{0.1}Te_{0.97}Se_{0.03}$ *single crystal for room-temperature radiation detection,*" **Journal of Materials Science: Materials in Electronics**, **32**, 26740-26749, 2021, DOI: https://doi.org/10.1007/s10854-021-07051-6 **(Editor's choice and featured in the cover page of the journal)**

5. Mandal, Krishna C; Oner, Cihan; Chaudhuri, Sandeep K; **Nag, Ritwik**; "*Metal-free (p+) diamond/(n)4H-SiC epitaxial Heterojunction Diodes for Radiovoltaic Applications,"* **IEEE Electron Device Letters – Accepted, in press; DOI:** https://doi.org/10.1109/LED.2025.3640092

6. Chaudhuri, Sandeep K; **Nag, Ritwik**; Roy, Utpal N, James, Ralph B Mandal, Krishna C; "*Determination of electron-hole pair creation energy in* $Cd_{0.9}Zn_{0.1}Te_{0.98}Se_{0.02}$ *quaternary semiconductor for room-temperature gamma-ray detection,*" **Electronics Letters, 60**, 17, 2024, DOI: https://doi.org/10.1049/ell2.70007

7. Chaudhuri, Sandeep K; **Nag, Ritwik**; Roy, Utpal N, James, Ralph B; Mandal, Krishna C; "*High-Resolution γ-Ray Spectroscopy in Capacitive Frisch Grid CdZnTeSe Detectors,"* **IEEE Electron Device Letters, 45,** 10, 1702-1705, 2024, DOI: 10.1109/LED.2024.3437230

8. Chaudhuri, Sandeep K; **Nag, Ritwik**; Ahmad, Iftikhar, Mandal, Krishna C; "*Alpha Particle Detection Using Highly Rectifying* Ni/Ga_2O_3*/4H-SiC Heteroepitaxial MOS Junction,"* **IEEE Transactions on Electron Devices**, **70**, 12, 6439-6445, 2023, DOI: 10.1109/TED.2023.3328329

9. Chaudhuri, Sandeep K; **Nag, Ritwik**; Kleppinger, Joshua W; Roy, Utpal N; James, Ralph B; Mandal, Krishna C; "*Charge Trapping Effects in THM-and VGF-Grown CdZnTeSe Radiation Detectors*," **IEEE Transactions on Nuclear Science**, **70**, 9, 2256-2263, 2023, DOI: 10.1109/TNS.2023.3306283

10. Kleppinger, Joshua W; Chaudhuri, Sandeep K; **Nag, Ritwik**; Roy, Utpal N; James, Ralph B; Mandal, Krishna C; "*Assessment of deep levels with selenium concentration in* $Cd_{1-x}Zn_xTe_{1-y}Se_y$ *room temperature detector materials*," **Applied Physics Letters, 123**, 6, 2023, DOI: https://doi.org/10.1063/5.0159519

11. Mandal, Krishna C; Chaudhuri, Sandeep K; **Nag, Ritwik**; "*High Performance Pd/4H-SiC Epitaxial Schottky Barrier Radiation Detectors for Harsh Environment Applications,*" **Micromachines, 14**, 8, 1532, 2023, DOI: https://doi.org/10.3390/mi14081532

12. Chaudhuri, Sandeep K; **Nag, Ritwik**; Mandal, Krishna C; "*Self-biased Mo/n-4H-SiC Schottky barriers as high-performance ultraviolet photodetectors,*" **IEEE Electron Device Letters**, **44**, 5, 733-736, 2023, DOI: 10.1109/LED.2023.3256344

13. Chaudhuri, Sandeep K; **Nag, Ritwik**; Mandal, Krishna C; "*A novel Ni/Y_2O_3/4H-SiC heteroepitaxial metal–oxide–semiconductor (MOS) betavoltaic cell*," **Journal of Materials Science: Materials in Electronics, 34**, 6, 543, 2023, DOI: https://doi.org/10.1007/s10854-023-09971-x

14. Chaudhuri, Sandeep K; **Nag, Ritwik**; Kleppinger, Joshua W; Mandal, Krishna C; "Investigation *of Charge Transport Properties and the Role of Point Defects in CdZnTeSe Room Temperature Radiation Detectors,*" **High-Z Materials for X-ray Detection: Material Properties and Characterization Techniques**, 171-188, 2023, Springer International Publishing Cham, DOI: https://doi.org/10.1007/978-3-031-20955-0_9

15. Chaudhuri, Sandeep K; Karadavut, OmerFaruk; Kleppinger, Joshua W; **Nag, Ritwik**; Yang, Gene; Lee, Dongkyu; Mandal, Krishna C; "*Enhanced Hole Transport in Ni/Y_2O_3/n-4H-SiC MOS for Self-Biased Radiation Detection,*" **IEEE Electron Device Letters, 43**, 9, 1416-1419, 2022, DOI: https://doi.org/10.1109/LED.2022.3188543

16. Karadavut, OmerFaruk; Chaudhuri, Sandeep K; Kleppinger, Joshua W; **Nag, Ritwik**; Mandal, Krishna C; "*Enhancement of radiation detection performance with reduction of $EH_{6/7}$ deep levels in n-type 4H–SiC through thermal oxidation,*" **Applied Physics Letters, 121**, 1-7, 2022, DOI: https://doi.org/10.1063/5.0089236

17. Kleppinger, Joshua W; Chaudhuri, Sandeep K; Karadavut, Omerfaruk; **Nag, Ritwik**; Watson, Daniel LP; McGregor, Douglas S; Mandal, Krishna C; "*Deep-level transient spectroscopy and radiation detection performance studies on neutron irradiated 250-μm-thick 4H-SiC epitaxial layers,*" **IEEE Transactions on Nuclear Science, 69**, 8, 1972-1978, 2022, DOI: https://doi.org/10.1109/TNS.2022.3168789

18. Karadavut, Omerfaruk; Chaudhuri, Sandeep K; Kleppinger, Joshua W; **Nag, Ritwik**; Mandal, Krishna C; "*Performance-Improved Vertical Ni/SiO_2/4H-SiC Metal–Oxide–Semiconductor Capacitors for High-Resolution Radiation Detection,*" **IEEE Transactions on Nuclear Science, 69**, 8, 1965-1971, 2022, DOI: https://doi.org/10.1109/TNS.2022.3168792

19. Kleppinger, Joshua W; Chaudhuri, Sandeep K; Karadavut, OmerFaruk; **Nag, Ritwik**; Mandal, Krishna C; "*Influence of carrier trapping on radiation detection properties in CVD grown 4H-SiC epitaxial layers with varying thickness up to 250 μm,*" **Journal of Crystal Growth, 583**, 126532, 2022, DOI : https://doi.org/10.1016/j.jcrysgro.2022.126532

20. Chaudhuri, Sandeep K; Kleppinger, Joshua W; Karadavut, OmerFaruk; **Nag, Ritwik**; Panta, Rojina; Agostinelli, Forest; Sheth, Amit; Roy, Utpal N; James, Ralph B; Mandal, Krishna C; "*Synthesis of CdZnTeSe single crystals for room temperature radiation detector fabrication: mitigation of hole trapping effects using a convolutional neural network,*" **Journal of Materials Science: Materials in Electronics, 33**, 3, 1452-1463, 2022, DOI: https://doi.org/10.1007/s10854-021-07623-6

21. Karadavut, OmerFaruk; Chaudhuri, Sandeep K; Kleppinger, Joshua W; **Nag, Ritwik**; Mandal, Krishna C; "*Effect of oxide layer growth conditions on radiation detection performance of Ni/SiO_2/epi-4H-SiC MOS capacitors,*" **Journal of Crystal Growth, 584**, 126566, 2022, DOI: https://doi.org/10.1016/j.jcrysgro.2022.126566

22. Chaudhuri, Sandeep K; Kleppinger, Joshua W; Karadavut, OmerFaruk; **Nag, Ritwik**; Mandal, Krishna C; "*Quaternary semiconductor $Cd_{1-x}Zn_xTe_{1-y}Se_y$ for high-resolution, room-temperature gamma-ray detection,"* **Crystals**, **11**, 7, 827, 2021, DOI: https://doi.org/10.3390/cryst11070827

CONFERENCE and POSTER PRESENTATION

1. **Nag, Ritwik**; Stefurak, Jarod; Chaudhuri, Sandeep K; Mandal, Krishna C; "*High-resolution real-time brain imaging system using novel CdZnTeSe semiconductor detector arrays,"* **Discover USC, 2025, April, Columbia, USA – Poster Presentation.**
2. **Nag, Ritwik**; Chaudhuri, Sandeep K; Mandal, Krishna C; "*Radiation Detection with Vertical Gradient Freeze Grown CdZnTeSe Crystals,"* **IEEE-NSS/MIC/RTSD, 2024, November, Tampa, Florida, USA – Poster Presentation – Winner of Best Poster Award.**
3. **Nag, Ritwik**; Chaudhuri, Sandeep K; Mandal, Krishna C; Ruddy, Frank H; "*High Resolution Cr/4H-SiC Radiation Detector for Harsh Environment Applications,"* **IEEE-NSS/MIC/RTSD, 2024, Tampa, Florida, November USA.**
4. Mandal, Krishna C; Chaudhuri, Sandeep K; **Nag, Ritwik**; Valdebran, Manual C; "*High Responsivity (p+)diamond/(n)4H-SiC Schottky Barrier Radiation Detectors,"* **IEEE-NSS/MIC/RTSD, 2024, November, Tampa, Florida, USA.**
5. **Nag, Ritwik**; Chaudhuri, Sandeep K; Mandal, Krishna C; "*Correlation of transport properties with charge trapping parameters in $Cd_{0.9}Zn_{0.1}Te_{1-x}Se_x$ room temperature gamma-ray detectors,*" **SPIE Optical Engineering + Applications, 2023, San Diego, California, USA.**
6. Karadavut, OmerFaruk; **Nag, Ritwik**; Kleppinger, Joshua W; Yang, Gene; Lee, Dongkyu; Chaudhuri, Sandeep K; Mandal, Krishna C; "*Investigation of $Ni/Y_2O_3/n$-4H-SiC metal-oxide-semiconductor structure for high-resolution radiation detection,"* **SPIE Optical Engineering + Applications, 2022, San Diego, California, USA.**
7. Karadavut, OmerFaruk; Kleppinger, Joshua W; **Nag, Ritwik**; Chaudhuri, Sandeep K; Mandal, Krishna C; "*Observation of minority carrier traps using C-DLTS in $Au/SiO_2/n$-4H-SiC vertical MOS capacitor*," **SPIE Optical Engineering + Applications, 2021, San Diego, California, USA.**
8. Kleppinger, Joshua W; Karadavut, OmerFaruk; **Nag, Ritwik**; Chaudhuri, Sandeep K; Mandal, Krishna C; "*High-resolution 4H-SiC Schottky barrier radiation detectors on 250 μm epitaxial layers for harsh environment applications*," **SPIE Optical Engineering + Applications, 2021, San Diego, California, USA.**
9. Chaudhuri, Sandeep K; Kleppinger, Joshua W; **Nag, Ritwik**; Roy, Kaushik; Panta, Rojina; Agostinelli, Forest; Sheth, Amit; Roy, Utpal N; James, Ralph B; Mandal, Krishna C; "*A CdZnTeSe gamma spectrometer trained by deep convolutional neural network for radioisotope identification*," **SPIE Optical Engineering + Applications, 2021, San Diego, California, USA.**