Malla Reddy College of Engineering & Technology

(AUTONOMOUS INSTITUTION_UGC, GOVT.OF INDIA)

Affiliated to JNTUH; Approved by AICTE, NBA-Tier 1, NAAC with A-Grade, ISO 9001:2015

ONLINE FACULTY DEVELOPMENT PROGRAMME (FDP)

on

"NANOTECHNOLOGY FOR VLSI: FABRICATION AND CHALLENGES"

***Organized by* MRCET *in association with* E & ICT Academy NIT PATNA**

Supported by

Ministry of Electronics and Information Technology (Meity), Govt. of India

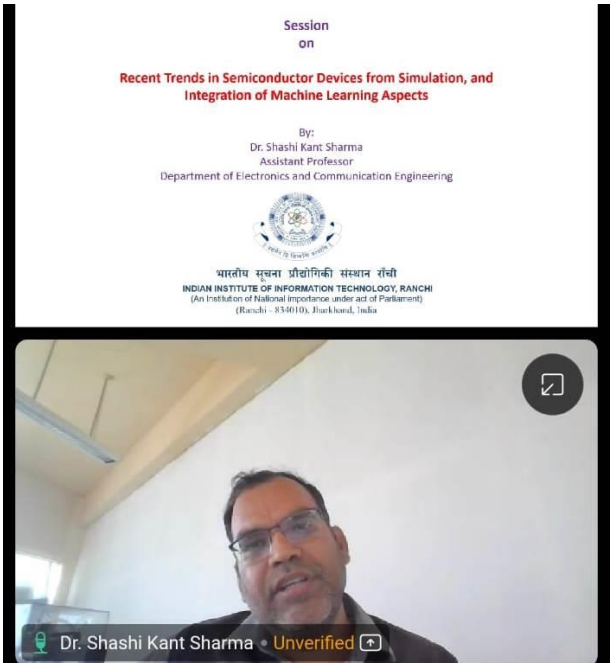
An online Faculty development programme on "**Nanotechnology for VLSI: Fabrication and Challenges**" was organised by **Malla Reddy college of Engineering & Technology** in association with **NIT Patna**, on FEB 3-7, 2025. During the FDP, Resource persons from Various IITs, NITs, IIITs and CSIR Laboratories were delivered insightful lectures and demonstrated their laboratory facilities with live examples of Nanomaterial's synthesis and characterisation techniques. Complete schedule of FDP is provided in ANNEXUREs

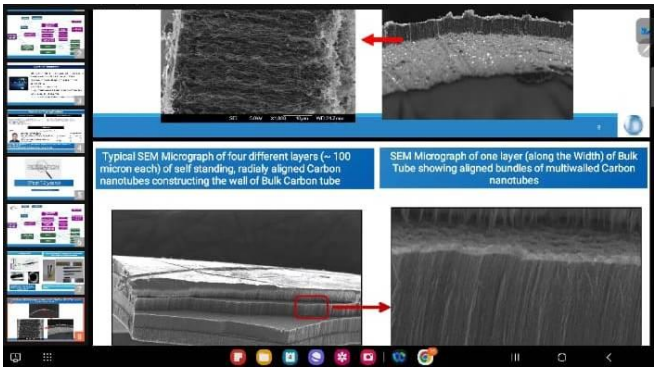
Heartfelt Thanks to our constant motivation **Shri Ch. Malla Reddy** sir, Chairman Malla Reddy Group of Institutions, **Dr. V.S.K. Reddy** Sir, Director, **Dr. S. Srinivasa Rao** sir, Principal, **Dr. Sesha Thalpa Sai** sir, Dean (R&D) and our vibrant HOD of H&S, **Dr V. Madhusudhana Reddy**, for giving an opportunity to organize the FDP

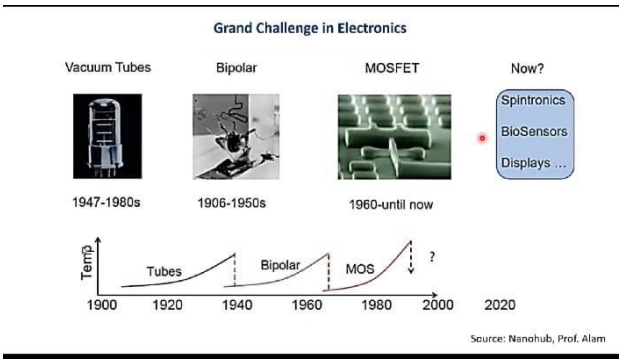
The FDP was started with an inaugural session on FEB 03, by co-ordinators **Dr. Pushpa Giri,** & **Dr. Jitendra Bahadur Maurya** at NIT Patna, and **Dr V. Madhusudhana Reddy** at MRCET, respectively, followed by other dignitaries.

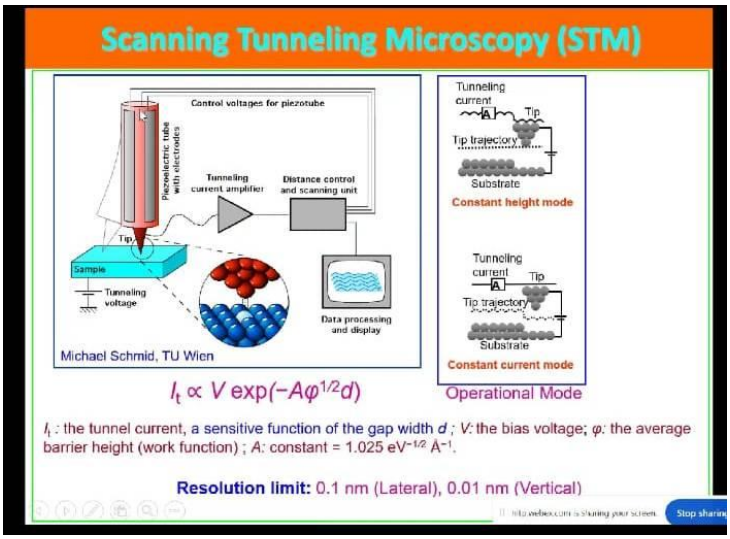
About the Theme of the Programme

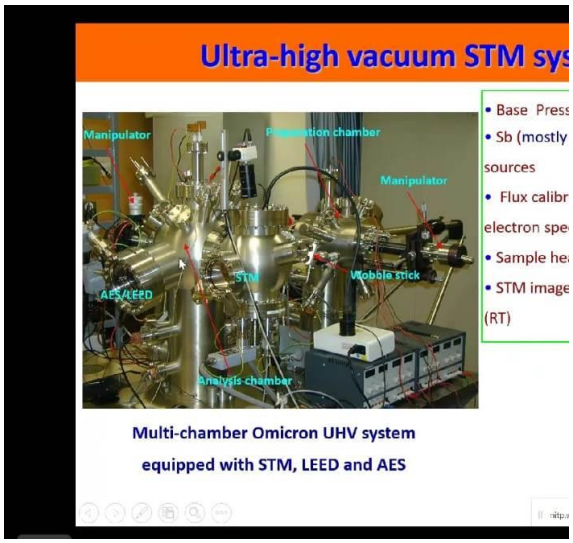
Nanotechnology plays a crucial role in VLSI fabrication by enabling the creation of incredibly small transistors and other electronic components on a single chip, achieved through the manipulation of matter at the atomic and molecular level, allowing for significantly increased circuit density and improved performance in microchips. To achieve these small features, advanced lithography techniques may be employed which use extremely short wavelengths of light to precisely pattern the circuit layout on the wafer. The nanotechnology offers a precise exposition of extremely thin layers of materials which is crucial for the nano scale structures on the wafer. Moreover, miniaturization reduces power consumption which will increase the durability of the device.


Session
on
Recent Trends in Semiconductor Devices from Simulation, and Integration of Machine Learning Aspects
By:
Dr. Shashi Kant Sharma
Assistant Professor
Department of Electronics and Communication Engineering
भारतीय सूचना प्रौद्योगिकी संस्थान राँची
INDIAN INSTITUTE OF INFORMATION TECHNOLOGY, RANCHI
(An Institution of National Importance under act of Parliament)
(Ranchi - 834010), Jharkhand, India
Dr. Shashi Kant Sharma • Unverified


Typical SEM Micrograph of four different layers (~ 100 micron each) of self standing, radialy aligned Carbon nanotubes constructing the wall of Bulk Carbon tube
SEM Micrograph of one layer (along the Width) of Bulk Tube showing aligned bundles of multiwalled Carbon nanotubes


Grand Challenge in Electronics
Vacuum Tubes
Bipolar
MOSFET
Now?
Spintronics
BioSensors
Displays …
1947-1980s
1906-1950s
1960-until now
Temp
Tubes
Bipolar
MOS
?
1900
1920
1940
1960
1980
2000
2020
Source: Nanohub, Prof. Alam


Scanning Tunneling Microscopy (STM)
Control voltages for piezotube
Piezoelectric tube with electrodes
Tunneling current amplifier
Distance control and scanning unit
Tip
Sample
Tunneling voltage
Data processing and display
Michael Schmid, TU Wien
Tunneling current
Tip
Tip trajectory
Substrate
Constant height mode
Constant current mode
$I_t \propto V \exp(-A\varphi^{1/2}d)$
Operational Mode
I_t: the tunnel current, a sensitive function of the gap width d; V: the bias voltage; φ: the average barrier height (work function); A: constant = 1.025 eV$^{-1/2}$ Å^{-1}.
Resolution limit: 0.1 nm (Lateral), 0.01 nm (Vertical)


Ultra-high vacuum STM sys
Manipulator
Preparation chamber
Manipulator
STM
Wobble stick
AES/LEED
Analysis chamber
• Base Press
• Sb (mostly
sources
• Flux calibr
electron spe
• Sample he
• STM image
(RT)
Multi-chamber Omicron UHV system
equipped with STM, LEED and AES

Every day, four sessions (two hours of each session) from morning 9 AM to 6 PM were presented by the guest speakers on various topics starting with *Advnces in nanoscale CMOS technology, Chip-scale optoelectronic devices based on semiconductor heterojunctions, Emerging research trends in thin film technology based devices for electronics and photonics applications, etc., followed by live demonstrations of Synthesis and characterization of nanomaterials, Demonstartion of sputtering, spin coating, and probe sonicator machines.*

Faculty and Researchers from MRCET, many universities, and Engineering colleges have registered for FDP and actively participated throughout the 5 days of FDP. Almost 100 participants were participated in FDP. The expertise and passion for the subject matter of the resource persons was truly impressive.

Feedback from participants was very positive & enriched with their understanding of nanotechnology and its applications in VLSI, and they are confident that the knowledge and insights gained will have a positive impact on teaching and research endeavours.

FDP BROUCHER

ABOUT MRCET

Malla Reddy College of Engineering and Technology (Autonomous) is approved by AICTE, New Delhi and affiliated to JNT University, Hyderabad. The MRCET College is offering B.Tech Programs in the areas of CSE,CSE-AI&ML, CSE-DS,CSE-CS,CSE-IOT, IT,EEE, ECE, ME, ANE and M.Tech Programs in CSE,ECE,ANE,ME and Master's in Business Administration (MBA). The college also has UGC Autonomous status for both Engineering and Management programs. The College also is accredited by National Board of Accreditation (NBA-Tier-1) and NAAC with 'A' Grade and is also recognized under UGC 2f & 12(B) status.The Instution is certified with ISO 9001:2015. The college has been ranked 'AAAA' Grade among india's Best Engineering college survey by Career360 (outlook Group). The College also ranked among the Top Engineering Colleges of Excellence in Telangana Competition Success Review (CSR). The department of MBA is endowed 9th Best B-School (Other than IIMs)in India.

ABOUT THE DEPARTMENT

The Department of Humanities and Sciences (H&S) has been established in the academic year 2004 with its main objective being "to deliver quality education and instill high patterns of discipline in order to make the students technologically superior and ethically strong thus improving the quality of human life."

The department is founded on the conviction that the Humanities give purpose, direction and value to education and life. Sciences provide a conceptual base in basic sciences which form a foundation to the engineering subjects. As a pillar to all the engineering departments, it comprises of five basic disciplines namely, English & Soft skills, Mathematics, Physics, Chemistry, and Management Sciences.

The Department of Humanities & Sciences plays a pivotal role in inculcating basic scientific knowledge and overall development of the child. It provides an ideal environment for the freshmen students to pursue their engineering by taking advantage of the well-established facilities and expertise available within the department and on-campus.

ABOUT THE PROGRAM

Nanotechnology plays a crucial role in VLSI fabrication by enabling the creation of incredibly small transistors and other electronic components on a single chip, achieved through the manipulation of matter at the atomic and molecular level, allowing for significantly increased circuit density and improved performance in microchips. To achieve these small features, advanced lithography techniques may be employed which use extremely short wavelengths of light to precisely pattern the circuit layout on the wafer. The nanotechnology offers a precise deposition of extremely thin layers of materials which is crucial for the nanoscale structures on the wafer. By the virtue of having smaller transistors, the devices will have faster switching speed which will result in increased computational capability. Moreover, miniaturization reduces power consumption which will increase the durability of the device.

PROGRAM OBJECTIVES

The FDP aims to provide participants with an in-depth understanding of cutting-edge deep learning technique and optimization methods tailored to address challenges in the healthcare domain. The program with focus on equipping faculty and researchers with theoretical knowledge, practical skills, and real-world applications in healthcare technology innovation. Participants will also gain insights into the latest advancements in AI-driven healthcare solutions. The program will foster collaboration and encourage the integration of these technologies to improve healthcare outcomes and efficiency.

- To know the VLSI Fabrication tools
- To know the characterization tools
- To know the fundamentals of nanotechnology
- To know the applications of nanotechnology in VLSI
- To know the application of nanotechnology inoptoelectronics devices

TOPICS TO BE COVERED

- Fundamentals of nanotechnology
- Fundamentals of VLSI fabrication.
- Fabrication tools and applications Characterization tools and applications
- Nanomaterial synthesis and applications
- Nanotechnology in semiconductor device
- Optical interconnects
- Fabrication of optoelectronics devices
- Fundamentals of semiconductor quantum nanophotonic
- Challenges and future scope of nanotechnology in device fabrications

RESOURCE PERSONS

- Prof. **P. Chakrabarti,** IIT BHU
- Prof. **Sudeb Dasgupta,** IIT Roorkee
- Prof. **Jawar Singh,** IIT Patna
- Prof. **Anchal Srivastava,** BHU
- Prof. **Govind Gupta,** CSIR NPL, New Delhi
- Prof. **Mayank Shrivastava,** IISc Banglore
- Prof. **Nandita Das Gupta,** IIT Madras
- Prof. **Shailendra K. Varshney.** IIT Kharagpur
- Prof. **Shriganesh Prabhu,** TIFR, Mumbai
- Dr. **Pramod Kumar Tiwari,** IIT Patna
- Dr. **C. Periasamy,** NIT Calicut
- Dr. **Amit Verma,** IIT Kanpur,
- Dr. **Santanu Manna,** IIT Delhi
- Dr. **Apurba Laha,** IIT Bombay and others

PROGRAMME SCHEDULE

Invited Talks					
Session/Date	**Monday (3rd Feb., 2025)**	**Tuesday (4th Feb., 2025)**	**Wednesday (5th Feb., 2025)**	**Thursday (6th Feb., 2025)**	**Friday (7th Feb., 2025)**
Session I **9 am to 11 am**	**Prof. Sanjeev Manhas, IIT Roorkee** (Advnces in nanoscale CMOS technology)	**Dr. Shivendra Jaiswal, NIT Patna** (Nanomaterial for membrane application)	**Prof. Sudeb Dasgupta, IIT Roorkee** (Forksheet and Nanosheets for next generation low power computing in beyond Moore Era)	**Dr. C. Periasamy, NIT Calicut** (Design and developments of FEMT based biosensor)	**Prof. P. Chakrabarti, IIT B.H.U.** (Fabrication and challenges of semiconductor devices)
11:00 am to 11:15 am	**TEA BREAK**				
Session II **11:15 am to 01:15 pm**	**Prof. Mukesh Kumar, IIT Indore** (Chip-scale optoelectronic devices based on semiconductor hetero-junctions)	**Dr. Shashi Kant Sharma, IIIT Ranchi** (Recent trends in semiconductor devices from simulation and integration of machine learning aspects)	**Prof. Sanjeev Manhas, IIT Roorkee** (LAB-1: Demonstartion of fabrication facilities)	**Prof. Anchal Srivastava, BHU** (LAB-2: Synthesis and characterization of nanomaterials)	**Prof. Jawar Singh, IIT Patna** (Device and Circuit for In-memory computing and neuromorphic)
01:15 pm to 01:45 pm	**LUNCH**				
Session III **01:45 pm to 03:45 pm**	**Dr. Shashi Kant Sharma, IIIT Ranchi** (Emerging research trends in thin film technology based devices for electronics and photonics applications)	**Prof. Anchal Srivastava, BHU** (Synthesis and characterization of nanomaterials)	**Prof. Shailendra K. Varshney. IIT Kharagpur** (Fabrication aspects of photonics nanostructure)	**Dr. Shivendra Jaiswal, NIT Patna** (LAB-3: Nanomaterial for membrane application)	**Prof. Mukesh Kumar, IIT Indore** (LAB-5: Demonstartion of fabrication and characterizatiof semiconductor photonic devices. lithography and alied facilities)
03:45 pm to 04:00 pm	**TEA BREAK**				
Session IV **04:00 pm to 06:00 pm**	**Prof. Govind Gupta, CSIR NPL, New Delhi** (Recent Advancements in Emerging and Advanced Optoelectronic Research)	**Dr. C. Periasamy, NIT Calicut** (Design and development of MEMS based sensor and actuators)	**Dr. Sunil Singh Kushvaha, Principal Scientist, CSIR-NPL** (Scanning probe microscopy: Seeing and fabrication at nanoscale)	**Dr. Pushpa Giri, NIT Patna and Dr. Jitendra Bahadur Maurya, NIT Patna** (LAB-4: Demonstartion of sputtering, spin coating, and probe sonicator machines)	**Dr. Sunil Singh Kushvaha, Principal Scientist, CSIR-NPL** (LAB-6: Demonstartion of pulsed laser deposition and allied systems)
06:00 pm to 06:30 pm					Valedictory Session/Certificate Distribution/Tea