Chalcogenide based phase change memory for non-volatile data storage

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Overview

The current demand of artificial intelligence (AI) for big data analysis in various research areas (from astronomy to drug discovery) facets out many challenges for computing devices based on von Neumann architecture. The standard computers use complex architectures with physically separated central computing units (CPUs) and memory units as well as many interconnected components. Such computers are energy inefficient and have limited information flow rate since the instructions are carried out only one at a time. To take advantage of AI technology being software-based technology, the today's direction of semiconductor industry is the development of alternative (hardware-based) computers in which memory and logic can co-exist in same form.

Chalcogenide based phase change materials (PCMs) show great potential for the emerging data storage devices by enabling non-volatile memory devices that can optimize the complex memory hierarchy and can merge computing with storage in memory cells. The working principle of phase change memory relies on ultrafast reversible phase transitions between crystalline and amorphous states of Ge-Sb-Te based material being induced either by electrical or optical pulses. Originally, it was proposed by S.R. Ovshinsky in the late 1960s, the memory technology was commercialized in optical storage media such as CD, DVD and Blu-ray disks. For data storage, phase change memory uses a large contrast either in electrical resistance or in optical reflectivity between the amorphous (logic state 0) and crystalline (logic state 1) state, while the continuous and non-linear change in the resistance and reflectivity upon partial amorphization or gradual crystallization can be used to emulate neuronal dynamics for neuromorphic computing.

Course Objectives

The course is intended for undergraduate and graduate students (B. Tech, M. Tech, M.Sc, PhD students) as well for faculty pursuing research. This course is for those who wish to explore their dream of becoming a scientist, inventor, innovator, researcher, technology incubators and engineering leaders in chalcogenide based phase change memory technologies.

The main objective of the course is to provide knowledge at basic and advanced level in the following topics:

i) To gain knowledge of current and emerging memory technologies

ii) To understand the concept of chalcogenide based phase change memory devices including circuits and system-level aspects,

iii) To explore chalcogenide material design for properties enhancement,

iv) To understand mechanism related to growth and phase transformations,

v) To gain knowledge of characterization and growth methods of chalcogenide materials

vi) To learn advanced applications of phase change memory such as multi-bit storage, neuromorphic computing etc.

Course Information	**Duration : 28th July 2025 to 01st August 2025** **Place : NIT Silchar , Assam , India** **Total Contact Hours : 16 hours (12 hours lectures and 4 hours tutorials)**
Modules and schedules	**A: <u>Day 1: 28-07-2025</u>** Lecture 1 (1h): Memory technologies and memory device architecture Lecture 2 (1h): Structure properties of chalcogenide material for non-volatile data storage **B: <u>Day 2: 29-07-2025</u>** Lecture 3 (1h): Local structure; Methods of structure analysis; Chemical bonding Lecture 4 (1h): Impact of disorder, composition and dimensions on material properties Tutorial 1 (2h): Structure determination by TEM & Measurements methods of glass forming ability

	C: Day 3: 30-07-2025 Lecture 5 (1h): Phase change mechanisms; Pressure-induced phase changes Lecture 6 (1h): Phase Change Memory: Multi-level storage, circuit and system-level aspects Lecture 7 (1h): Phase transformations induced by ion and electron beams **D: Day 4: 31-07-2025** Lecture 8 (1h): Glass forming ability & aging mechanism Lecture 9 (1h): Phase-change memory as a programmable synapse Lecture 10 (1h): Crystallization kinetic and its tailoring Tutorial 2 (2h): Thin film deposition using RF/DC magnetron sputtering system, pulsed laser deposition (PLD) and molecular beam epitaxy (MBE) **E: Day 5: 01-08-2025** Lecture 11 (1h): Materials engineering for device optimization Lecture 12 (1h): Hetero-structured phase change materials **MCQ based examination** **Valedictory**
Who can attend …	• Executives, engineers and researchers from manufacturing, service and government organizations including R&D laboratories. • Students at all levels (BTech/MSc/MTech /PhD). • Faculty from reputed academic and technical institutions. • Others who want to learn the basic and advanced concepts dealing with chalcogenide based phase-change memory its applications.

Fees	The participation fees for taking the course is as follows: a. Participants from abroad: USD 250 b. Participants from Industry/Research Organizations: Rs. 5000/- c. Participants from Academic Institutions: i. Faculty member: Rs. 2000/- ii. External Students: Rs. 500/- iii. Internal PG & PhD Students: Rs. 500/- iv. Internal UG Students: Nil The above fee include all instructional materials, computer use for tutorials and assignments, laboratory equipment usage charges, 24 hours free internet facility. The participants may be provided with accommodation on payment basis.

The Faculty (Expert)

Dr. Andriy Lotnyk
Group Leader and Head,
Leipzig nanoAnalytics (LenA),
Leibniz Institute of Surface Engineering (IOM Leipzig),
Germany.

Priv.-Doz. Dr. habil. Andriy Lotnyk gained his Diploma in Physics (with honours) from the V. N. Karazin Kharkiv National University (Ukraine) in 2002. He completed his PhD work at the Max Planck Institute of Microstructure Physics in Halle/Saale (Germany) and received PhD degree (with summa cum laude) from the Martin Luther University of Halle-Wittenberg (Germany) in 2007. After his postdoctoral work at the Max Planck Institute, Dr. Lotnyk was scientific staff at the University of Kiel (2009–2011). In 2011, he moved to Leibniz Institute of Surface Engineering (IOM), Germany as head of the Leipziger nanoAnalytics center. In 2022, Dr. Lotnyk completed his Habilitation (the highest university degree in Germany) for experimental physics at the University of Leipzig (Germany). He is also part-time Professor (jianzhi jiaoshou (Teilzeitprofessor)/Ningbo University) at the Ningbo University in China. His current research focuses on nanoscale characterization of materials, thin film growth and surface modification of thin films as well as design and development of phase change memory thin films.

Dr. Shivendra Kumar Pandey
Assistant Professor,
Department of Electronics & Instrumentation Engineering,
National Institute of Technology Silchar, Assam, India

Dr. Shivendra Kumar Pandey graduated in Electronics and Communication Engineering from RGPV Bhopal, India. In Jan 2018, he received Ph.D. in Electrical Engineering from IIT Indore, India. Since Jun 2018, he has been working as Assistant Professor of Technology Silchar, Assam, India. He obtained the Early Career Research (ECR) Award and the Paired Early Career Fellowship in Applied Research (PECFAR) Award from the Science and Education Research Board (SERB) and the Indo-German Science & Technology Centre (IGSTC), respectively. He has published research articles in Applied Physics Letters, Journal of Applied Physics, Scripta Materialia, ACS Applied Electronic Material, Review of Scientific Instruments, Physica Status Solidi-Rapid Research Letters etc. His current research interests include Emerging memory technologies (PCM, RRAM), Nanoelectronics, VLSI Devices, Sensors. He is Principal Investigator of the Nano-electronics & Emerging Memory (NEEM) Research Laboratory at NIT Silchar, Assam, India.

Course Coordinator

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शिक्षा मंत्रालय
MINISTRY OF
EDUCATION
सत्यमेव जयते

GLOBAL INITIATIVE OF ACADEMIC NETWORKS

About Silchar

Silchar is the second largest town in the state of Assam. It was the kingdom of the Kachchari kings from 1755 to 1830. It was annexed to the British East India Company in 1833. The city has now attained a cosmopolitan status with inhabitants from all over India although Bengali speaking people constitute the majority. It is an educational and business hub in North East India next to Guwahati. Aesthetically the campus is very beautiful with greeneries and wet lands.

How to reach NIT Silchar

The city is well connected by Road, Train and Air. There are direct flights from Kolkata and Guwahati and trains from New Delhi, Kolkata, Guwahati, and Agartala. Daily bus services are available from Agartala, Guwahati, Aizawl, and Imphal. The Institute is located around 35 kms from the Silchar airport, 10 kms from the Silchar railway station, 14 kms from ISBT Silchar, and 8 kms from the heart of the Silchar town. Prepaid taxi and auto services are available from Silchar.

Registration Guidelines (Step-by-Step):

1. Courses Registration for GIAN course may be done by paying the requisite fees as below through SBI collect.
   SBI Collect Name: GIAN COURSE NIT SILCHAR, 2412353, Shivendra Kumar Pandey.
   a. Participants from abroad: USD 250
   b. Participants from Industry/Research Organizations: Rs. 5000/-
   c. Participants from Academic Institutions:
   i. Faculty member: Rs. 2000/-
   ii. External Students: Rs. 500/-
   iii. Internal PG & PhD Students: Rs. 500/-
   iv. Internal UG Students: Nil

2. Fill out the Registration form given below, sign it. Send the scan copy of the filled in form with scanned copy of course fee transaction slip obtained by SBI collect to the course coordinator e-mail address (skpandey@ei.nits.ac.in). This is for the Course Coordinator's record. Now, await the Course Coordinator's confirmation.

GIAN: Global Initiative of Academic Network

NAME OF THE COURSE: CHALCOGENIDE BASED PHASE CHANGE MEMORY FOR NON-VOLATILE DATA STORAGE

(Course ID: 2412353)
Dates: 28th July 2025 to 01st August 2025
Department of Electronics and Instrumentation Engineering, NIT
Silchar, Assam, India

REGISTRATION FORM

GIAN Portal Application Number:

Full Name: Category (Industry/Academic/Student):

Organization:

Address:

Email Id:

Mobile Number:

Highest Academic qualification:

SBI Collect payment details:

Transaction Id/Ref No	Date	Amount

Accommodation Required: Yes/No (please tick in the applicable field)

Date:

Place:

Signature of Applicant