Defence Seminar

Seminar Title	: Performance Assessment of Futuristic Novel TFET Architectures for Ternary CMOS and Biosensor Applications
Speaker	: Priyanka Karmakar (Rollno : 518ee1002)
Supervisor	: Prasanna Kumar Sahu
Venue	: EE 401
Date and Time	: 19 Mar 2025 (10:30 AM)

Abstract : With the advancement of the electronics industry, there is a growing need for increased integration levels and cost-effective technologies. With the constant downscaling of CMOS technology, high-speed MOS devices have been developed that are ideal for analog/RF applications. It is crucial to have systems that prioritize low distortion and linearity as fundamental components of their design. But nowadays, due to the downscaling, the CMOS technology faces many challenges regarding short-channel effects (SCEs). This resulted in the need for new device architecture and design. One prospective candidate for enhancing the performance of scaled CMOS integrated circuits is a tunnel field effect transistor (TFET). A vertical TFET with a pocket (VP-TFET) has been used to design a ternary inverter. In VP-TFET, a thin silicon channel layer is interposed between the source and gate oxide. P+ pocket is present in the channel close to the source region. The ternary inverter is a multi-valued logic (MVL). MVL helps to reduce power density on a chip. Ternary logic has three steady states ("0", "1", and "2"), which store more data in the same amount of space. A vertical TFET has been used to detect the biomolecules. The dielectric constant is altered by immobilizing biomolecules within the carved cavities, which were previously filled with air. This modification changes the electrical properties of the device. In VB, vertical and lateral tunneling occurs, which increases the tunneling carriers, the current increases, and eventually, the sensitivity of the biosensor is enhanced. The Poc-MGOTFET-based biosensor is used to detect breast cancer cell lines. The gate oxide of the Poc-MGOTFET-based biosensor is carefully placed at an optimized depth within the channel. The SiO2 layer within the nanogap cavity serves as an adhesive layer for the cell lines. The N+ pocket is incorporated at the source side, and the gate has an extended structure. The cavity is etched beneath the gate electrode for biomolecule immobilization. Breast tissue included healthy (MCF-10A) and cancerous (MCF-7, T47D, Hs578T, and MDAMB-231) cell lines. The detection method of the biosensor is based on differences in the dielectric constants of different breast cancer cell types. The dielectric constant is altered by immobilizing the cancer cells within the carved cavities, previously filled with air. This modification changes the electrical properties of the device. Sensitivity analysis considers drain current, transconductance, ION/IOFF ratio, and VT. Maximum sensitivity is observed in T47D (k = 32) breast cancer cells because it has a higher dielectric constant. The selectivity is calculated between the healthy and cancerous breast cancer cell lines. The effect of an irregular cell line confined in the cavity has been investigated to evaluate the ability of the device to detect breast cancer cell lines. The PocMGOTFET-based biosensor can detect breast cancer biomarkers (C-erb-B-2). The effective charge caused by the existence of C-erbB-2 biomarker in serum/saliva is utilized as the interface charge of the device for detecting CerbB-2 biomarker. Sensitivity analysis considered the ION/IOFF ratio.

Keywords: TFET, Band-to-band tunneling (BTBT), Hetero gate dielectric oxide, Modified gate oxide (MGO) depth, Line BTBT, Vertical BTBT, Vertical TFET, Biosensor, Nanogap cavity, Biomolecules, Dielectric modulated TFET, Sensitivity, Selectivity, Breast cancer cell lines, Breast cancer biomarker, Interface charge modulation, C-erbB-2, Ternary Inverter (T-Inverter), Ternary CMOS (T-CMOS), Ternary VTC (T-VTC).