ABSTRACT

CMOS technology utilizing high-mobility InAs based channels is expected to be one of the promising devices for high-performance and low-power analog circuits in the future. Low effective mass of InAs makes mobility of electrons in InAs to be about 20 times that of Silicon at room temperature making it applicable for high speed applications. However, the most important critical issue faced with InAs based devices is the problem of leakage current. But, device/process/integration technologies of InAs based n-MOSFETs for meeting this requirement for future node MOSFETs are being continuously explored.

Moreover, keeping pace with the development of III-V CMOS technology and the search to get newer materials through combinations of III-V compound semiconductors, thin-body InGaSb semiconductors are emerging out as the choice channel material for designing high mobility p-channel MOSFETs with improved OFF -state characteristics.

The present work deals with the device physics and design of thin-body InAs based on-insulator structure as well as with quantum-well n-MOSFET structure having raised source-drain architecture. This also includes a study on the device performance of thin-body InGaSb based quantum well p-MOSFET having raised source-drain architecture. A detailed investigation of the analog and digital as well as linearity performance of InAs n-MOSFET and InGaSb p-MOSFET has been made. The effect of variation of channel thickness and angle of grooving on the analog parameters viz. transconductance (g_m), output conductance (g_d) tranconductance efficiency factor (g_m/I_D), device gain (g_m/g_d) in a wide temperature range of 150 K to 300 K has been studied. Digital performance parameters like on current (I_{ON}), off current (I_{OFF}), I_{ON}-I_{OFF} ratio and intrinsic delay within the same temperature range has also been well explored.

Apart from device level analysis, the author has performed the circuit level analysis also to understand the linearity analysis of the circuit built with device. Distortion characteristics, extracted by integral function method (IFM) in terms of second and third order harmonic distortions (HD_2 and HD_3) and also total harmonic distortion (THD) of common-source amplifier built with InAs quantum-well n-MOSFET with varying groove angle has been studied.

Research on radiation effects in the category of single event effects on InAs quantum well n-MOSFET with raised source- drain architecture in the presence of Neon, Krypton and Xenon ions has also been explored by the author. This study relates to the changes caused in the output response of a device by an energetic particle, striking the middle of the device channel. Transient response analysis, total collected charge, charge collection efficiency, full width at half maximum (FWHM), rise time and pulse width with respect to changed angle of grooving and channel thickness are included in this study.