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Multi-Gate Device Architectures for GaN based Power Switching Devices.

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The use of multiple gates to control the channel regions formed in a thin vertical body has now become mainstream in digital CMOS devices. These devices also called FinFETs , MugFETS or Ultra-thin body devices(UTB-Devices) offer significant challenges and opportunities for GaN based power switching devices. In silicon CMOS UTB devices the gate workfunction sets the threshold voltage and the traditional doping in the channel region can be minimized or eliminated. The vertical channel region allows for new means to increase the on-state current by increasing the total channel region of the MOSFET compared to both traditional planar lateral devices.

To form GaN based multi-gate MOSFETs three new concepts are explored in this paper. 1) Formation of GaN MOSFETs on GaN wafers 2) Formation of GaN multi-gate devices on GaN regions grown on 111 silicon and 3) Multi-Gate devices formed on GaN regions formed on 111 sidewalls formed on silicon. The three devices mentioned above have respective advantages and challenges. The most significant advantage offered by all these devices is the increased channel region and better gate control made possible by multi-gate architectures.

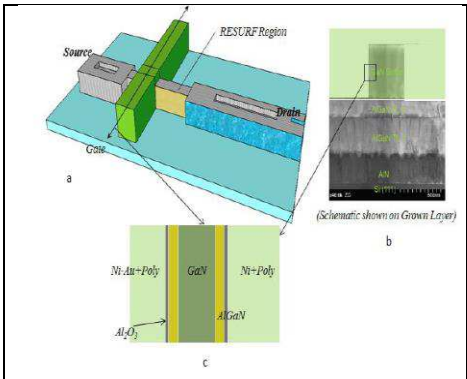

Fig 1a: Schematic of Multigate thin-body device on SOI and cross section of channel region,

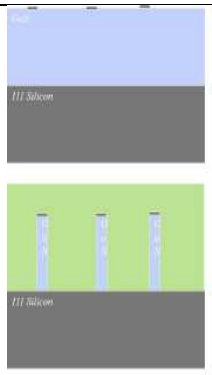

Fig 1b: flow for patterned GaN regions with grown channel regions for channel.

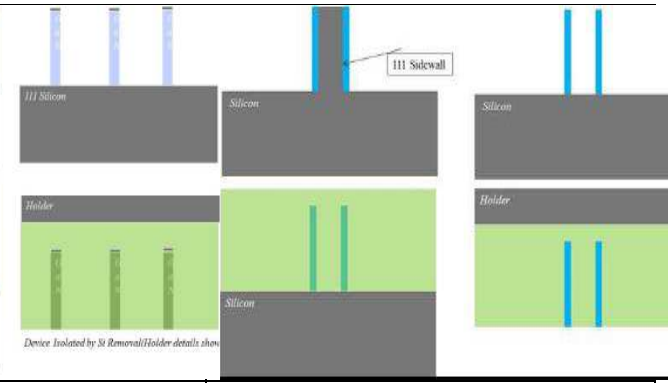

Fig 1c: proposed growth of GaN on 111 sidewall regions to further form channel region.

The impact of architectural changes such as body tie and source/drain engineering for power devices has been studied for silicon and some of the new insights on the breakdown characteristics for high voltage devices and methods to improve breakdown characteristics will be presented. Some of the the learning from these silicon devices translate to similar architectures using GaN channel regions. There is significant scope for innovation and development in the proposed devices and is expected to allow new applications in RF and power switching applications.