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INVESTIGATION OF PMOS CAPACITOR PERFORMANCE BY VARYING SEMICONDUCTOR MATERIALS USING SILVACO TCAD TOOLS

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AUTHOR'S DECLARATION

I declare that the work in this thesis was carried out in accordance with the regulations of Universiti Teknologi MARA. It is original and is the results of my own work, unless otherwise indicated or acknowledged as referenced work.

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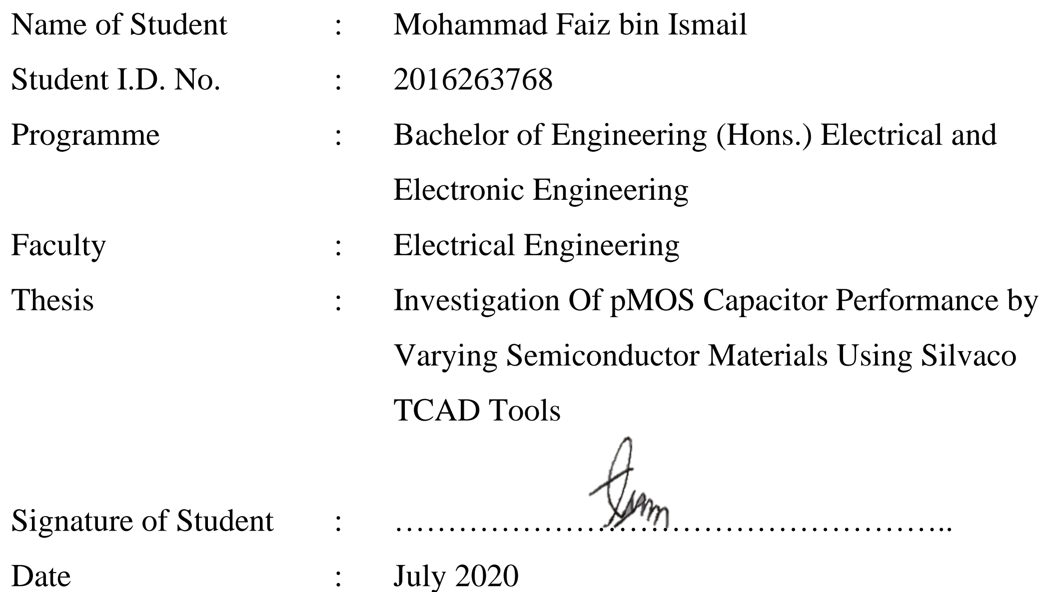

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ABSTRACT

Metal oxide semiconductor (MOS) capacitor is a trilayer device that comprises of metal, dielectric and semiconductor layer. The advancement of MOS technology has greatly give huge improvement to MOS devices which lead to scaling down the MOS devices. The reduction of dielectric thickness has coming to an end so an alternative of using material with high mobility carrier as semiconductor base material is investigated. The objective of this work is to study the performance of p-type MOS (pMOS) capacitor by varying the base material for semiconductor to silicon (Si), germanium (Ge) and silicon germanium (SiGe). The performance of the pMOS was evaluated based on the capacitance-voltage (C-V) and current-voltage (I-V) characteristics. The simulation was done through Silvaco TCAD tool which comprising of ATHENA and ATLAS simulator ease the method of investigation. Result for C-V characteristics showed that pMOS capacitor fabricated using Ge and $S_{i3}N_4$ as base material and dielectric layer, respectively has voltage threshold, $V_T = 4.15V$ and $C_{max} = 2.61 \times 10^{-14}F$. pMOS capacitor fabricated using SiGe as base material and $S_{i3}N_4$ as dielectric layer has voltage threshold, $V_T = 4.28V$ and $C_{max} = 1.30 \times 10^{-14}F$. The performance of both pMOS capacitor are better compared to Si with $V_T = 4.38V$ and $C_{max} = 6.75 \times 10^{-15}F$. Based on the obtained results, Ge is chosen as the best material to be used as the semiconductor layer supported by recent researchers. As compared to SiGe, the C_{max} value of Ge is higher that enable the device to store more charge with low voltage to operate the MOS device.

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