UNIVERSITI TEKNOLOGI MARA

FREE SPACE MICROWAVE MEASUREMENT OF PERMITTIVITY OF GATE DIELECTRIC FOR SEMICONDUCTOR TECHNOLOGY

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Thesis submitted in fulfilment of the requirements
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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 acknowledge as reference work. This thesis has not been submitted to any other academic institution or non-academic institution for any other degree or qualification.

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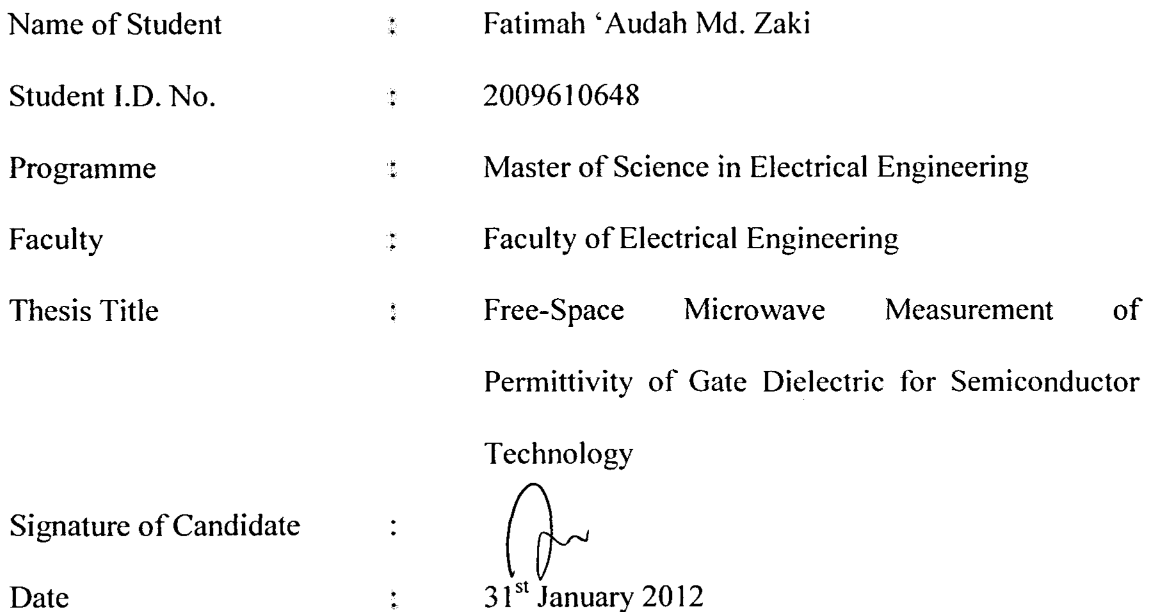

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ABSTRACT

A non-destructive and non-contacting technique for measuring the relative permittivity of an epitaxial layer on semiconductor has been developed. The samples were thermally grown SiO_2 of different dopants and thicknesses. The measurement set up consists of spot-focusing horn antennas and a vector network analyzer for measuring the reflected signals in free space. By applying some calculations, the dielectric constants and other electrical properties of silicon dioxide can be obtained. Results for p- and n-type SiO_2 are reported in the frequency range of 18 to 26 GHz.

This measurement technique is able to differentiate between doped and undoped materials. It was found that the doped SiO_2 layer absorbed more signals than the undoped ones due to different conductivity values as the result of dopant addition. Moreover, different result is shown by n- and p-type wafers which are caused by depletion and pile-up effect in the semiconductor as the outcome of the oxidation of silicon surface. The dielectric constants of the SiO_2 films were found to be approximately 3.8 at 22 GHz, which agrees with other researchers.

The research also found that this method can distinguish different oxide thicknesses, where fewer signals are being reflected for thicker oxides. It was observed that the S_{11} reduction is insignificant for oxide thickness greater than the skin depth. Furthermore, the conductivity and loss tan of SiO_2 increases with increasing oxide thickness. The method is able to measure relative permittivity of double-layered dielectric or media, provided the layer thickness does not exceed skin depth. This shows that the measurement technique is reliable because it is sensitive to the properties of the epitaxial layer only.

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