

# Dependent Effective Index Analysis for a Nano-scale Silicon Waveguide in Transverse Mode

A. T. C. Chen\*, R. Petra\*\*, K. S. K. Yeo\*\* and M. Rakib Uddin\*\*\*

\*Electrical and Electronic Engineering Programme Area, Faculty of Engineering, Universiti Teknologi Brunei (UTB) Gadong, Brunei Darussalam

\*\* Universiti Teknologi Brunei (UTB) Gadong, Brunei Darussalam

\*\*\* The State University of New York Research Foundation, State University of New York Polytechnic Institute, Fuller Road, Albany, New York 12203

[angie\\_teo236@hotmail.com](mailto:angie_teo236@hotmail.com), [rafidah.petra@utb.edu.bn](mailto:rafidah.petra@utb.edu.bn), [kenneth.yeo@utb.edu.bn](mailto:kenneth.yeo@utb.edu.bn), [mmrakib@yahoo.com](mailto:mmrakib@yahoo.com)

**Abstract**— In this paper, we propose and demonstrate the effect of effective index on silicon waveguide dimensions by using MODE solution. The objective of this paper is to study the effect of effective index which is influenced by waveguide width variations and waveguide height variations. The effect of effective index variations is presented by fixing the core height at 200nm and varying the core width from 300nm to 600nm and by fixing the core width at 500nm and varying core height from 150nm to 300nm for Transverse Electric (TE) and Transverse Magnetic (TM) MODE. With the simulation results, the thickness of the core width and core height are used for the determination of fundamental or higher order mode design. It is seen that higher effective index can be achieved as the core width and core height increases. The determination of fundamental or higher order mode design can be achieved by analyzing the graphs of effective indices for TE<sub>0</sub>, TM<sub>0</sub>, TE<sub>1</sub> and TM<sub>1</sub> modes at varied core height and width. Based on the analysis, it is concluded that fundamental order can only be achieved when the silicon core width is kept at a value of approximately 500nm and core height is kept at a value if height less than 250nm. At a higher order mode, excess noise and losses can be introduced.

**Keyword**— Core Height, Core Width, Effective Index, Rib waveguide and Silicon



**A.T.C.Chen** (M'21). Angie Teo Chen was born in Brunei Darussalam on June 23, 1995. She received her BSc in electrical and electronic engineering from Universiti Teknologi Brunei, Brunei Darussalam in 2014. She is currently having her PhD degree in electrical and electronic engineering in Universiti Teknologi Brunei, Brunei Darussalam and started since 2019.

She has three papers in international conference proceedings. She had presented her first paper in Brunei Darussalam for Brunei International Conference on Engineering and Technology (BICET) in 2018. In 2019, she had presented her second paper in Kuala Lumpur for 4th IEEE International Circuit and System Symposium (ICSyS). Her third paper is presented in South Korea for 22nd International Conference of Advanced Communications Technology in 2020. Her research focuses mainly on various nano-scale waveguide structure to see the device performance characteristics by applying her waveguide design variations and characterize the device performance.

Ms. Chen is a member of IEEE. Ms. Chen got her BSc degree with first class honors and received Excellent Student Award from the Ministry of education, Brunei Darussalam. Ms. Chen received UTB Scholarship Award for her programme, PhD in electrical and electronic engineering.



**Rafidah Petra** received the B.Eng. degree Electrical & Electronic Engineering from Glasgow University, UK, under twinning programme with University Brunei Darussalam (UBD), in 2004. She received her master's degree in Nanoelectronics & Nanotechnology, from the University of Southampton, UK, where she further her studies and obtained her PhD in Electronics and Electrical Engineering from the same University. Her major is in silicon nano-photonics technology for telecommunications where she specializes on the design, fabrication and characterization of nanoscale waveguide devices. Her expertise is in thin-film fabrication for devices at nanometer scale, for the application of solar cells and sensors for environmental sensing.

She is currently an Assistant Professor at Universiti Teknologi Brunei (UTB), Bandar Seri Begawan, Brunei Darussalam. She has been working as an educator since she graduated from her bachelor's degree, back in 2004 and progressively

becomes an active academia, where she has been involved both in teaching and research.

She is a member of the IET and an active member for Centre for Innovative Engineering. She currently holds the position as deputy director for Corporate Communications Office, UTB



**Kenneth S. K. Yeo** received the B.Eng. degree (with honours) in electronic and communication engineering and the Ph.D. degree from Birmingham University, Edgbaston, Birmingham, U.K., in 1996 and 2000, respectively. In 2009, he received the PG Cert in learning and teaching in higher education from University of East London, London, UK. His doctoral research concerned high-temperature superconducting microwave devices.

He is currently a Senior Assistant Professor at Universiti Teknologi Brunei (UTB), Bandar Seri Begawan, Brunei Darussalam. Prior to joining UTB, he was a Senior Lecturer at University of East London, London, UK for nearly 10 years. He worked as a Principle RF Engineer at CryoSystems Ltd., Luton, U.K. between 2004 and 2006. He has spent more than 6 years at the University of Birmingham, as Research Fellow. From 2013 to 2017, he also served as External Link Tutor at Canterbury Christ Church University, Canterbury, Kent, U.K while working at University of East London. In Mar 2016 and May 2017, he was also a Visiting Professor at Hangzhou Dianzi University, Hangzhou, China.

Dr. Yeo is a qualified Chartered Engineer with Engineering Council, UK and a member of IET. He is also a Fellow of HEA, UK.



Dr M. Rakib Uddin was born in Bangladesh on February 18, 1978. He received his PhD degree in communication engineering from KAIST, Daejeon, Korea in 2010. He received his MSc in Electrical and Electronic Engineering from Bangladesh University of Engineering and Technology, Dhaka, Bangladesh in 2005 and BSc in Electrical and Electronic Engineering from Chittagong University of Engineering and Technology, Chittagong, Bangladesh in 2002. He is currently a Research Engineer at the State University of New York Polytechnic Institute, Albany, New York, USA.

He worked as ASSOCIATE PROFESSOR with Electrical and Electronic Engineering Programme Area, University Teknologi Brunei (UTB), Bandar Seri Begawan, Brunei Darussalam from December 2014 to December 2020. He worked for Samsung Electronics/Samsung Advanced Institute of Technology, Hwaseong/Geheung, Korea as research staff Member/Senior Engineer from 2011 to 2014. He worked as post-doctoral fellowship with KAIST from 2010 to 2011. He has more than 60 articles in international journals and conference proceedings along with seven international patents.

Dr Rakib Uddin is a Senior member of IEEE, USA and Member of IET, UK. He got Korean government IITA full scholarship for his PhD programme from 2006 to 2010 at KAIST. He also got Korean Government Brain Korea 21 (BK21) fellowship for his post-doctoral research with KAIST, Korea. Dr Rakib Uddin received University Teaching as well as Research Excellence Awards in 2017 and 2019 at UTB, Brunei Darussalam.