MODELING AND EXPERIMENTAL STUDIES OF SCHOTTKY-CONTACTED COPLANAR WAVEGUIDE TRANSMISSION LINES ON SEMICONDUCTOR SUBSTRATES

APPROVED BY

DISSERTATION COMMITTEE :

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This work is dedicated to my father, Md. Nurul Islam, my mother, Sharifunnessa Islam, my brother, Iftekharul Islam (Titon), my sister, Shahzia Islam (Anton) and my beloved wife Moriom Azad (Lima)

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by

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DISSERTATION

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MODELING AND EXPERIMENTAL STUDIES OF SCHOTTKY-CONTACTED CO-PLANAR WAVEGUIDE TRANSMISSION LINES ON SEMICONDUCTOR SUBSTRATES

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An extensive study has been performed on Schottky-contacted coplanar waveguide (CPW) distributed transmission lines on lossy semiconductor substrates in this dissertation. The study includes the modeling of the planar line both from series and shunt circuit perspectives and rigorous experimental work to support the modeled results. In addition, it has been shown that the transmission line can successfully be used to implement either Schottky-controlled or optically-controlled phase shifters that can operate well into the millimeter wave regime (at least up to 40 GHz).

The model to calculate conductor losses due to the CPW electrodes is based on quasi-static conformal mapping of the CPW structure. The non-uniformity of the current distribution along the CPW conductors is transformed into a uniform

distribution in the mapped domain, where the conductivity becomes irregular. The mapped conductor surfaces are then analyzed and a scaled surface impedance is calculated, from which the series impedance is evaluated. The modeled results show an accurate match with wide range of experimental results. Besides the conductor loss calculation, the lossy shunt circuit is modeled as well, which provides the physical interpretation of the actual propagation control mechanism of a Schottky-contacted CPW phase shifter. This model is also supported by various experimental results. In addition to these models, extensive experimental work has been performed to implement an optically-controlled phase shifter based on a semiconductor substrate. Improvements in phase shifter performance have been obtained with the use of an advanced processing technique for hybrid integration. This also allows the possibility of an integrated phase shifter with a semiconductor laser source on a single quartz substrate.

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