Non-linear Characteristics of an Optically Reconfigurable Microwave Switch

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Recently, there has been a growing interest in designing tunable microwave circuits. Varactors, PIN diodes and RF MEMS are listed as strong candidates [1]. Photoconductivity based tuning in silicon, despite its lossy behaviour, can be a potential alternative due to its greater power handling capabilities, high isolation between the controlling optical beam system and the microwave circuit, and reduced non-linear effects [2]. This paper presents results for a bottom illuminated superstrate tuned microstrip gap line and its non-linear behaviour in terms of Third Order Intercept Point referred to input power (IIP3) in the presence of a two-tone RF signal. Measured S-parameters results agree with CST simulations, demonstrating the effectiveness of the proposed model. The reported results suggest that the proposed architecture has the potential for producing a highly linear, high power and low loss microwave switch.

Figure 1(a) shows the side view of a gapline based on a superstrate antenna design. A 0.5mm transparent fused silica glass substrate is used (ε=3.5). A gold microstrip gap line is lithographically defined on the fused silica, the gold thickness is 350nm with a 5nm thick titanium layer to improve adhesion. A piece of silicon, 5mm x 2mm x 0.5mm (ε=11.9) is used as a superstrate. Optical illumination is provided by a fibre coupled laser diode with a wavelength of 980nm with a 1mm diameter spot. An electron-hole plasma is generated in the silicon with the high conductivity region close to the microstrip gap. The lossy, lower conductivity tail is contained within the silicon and hence, far from the high microwave field region in the gap and in the fused silica substrate, which substantially reduces losses compared to previous configurations [3].

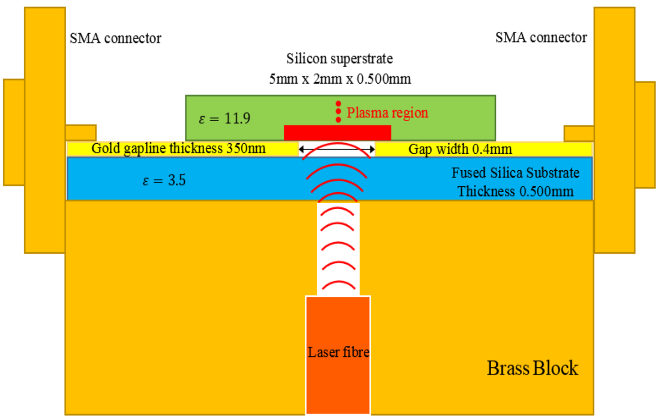

Figure 1(a) Side view of superstrate gapline strucutre design

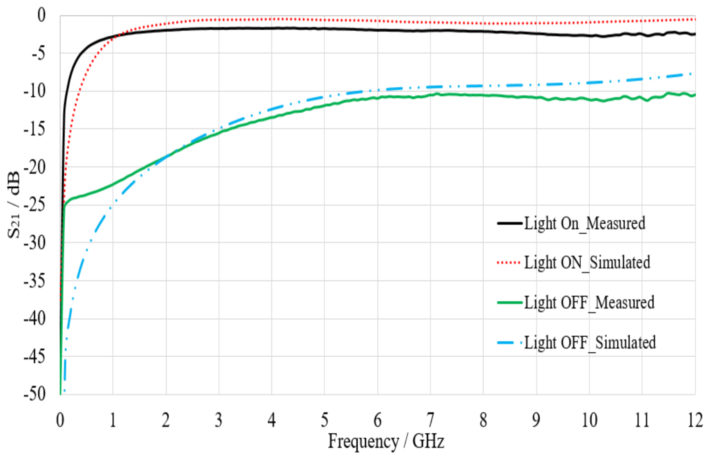

Figure 1(b) Measured and simulated S_{21} results

Figure 1(b) shows the S_{21} response for the dark state and an illumination power of 1W with 2500S/m used for the surface conductivity in CST. Also shown is a less than 2dB insertion loss and around 20dB isolation that have been achieved at 2GHz. The two-tone non-linearity measurements (not shown here) show a very good IIP3 of 70dBm. The maximum input power for each of the two tones before combining was nearly 20W which also has pointed out its high power handling ability. In future, collimated optical illumination will be used and the laser spot size and gap will be optimised to significantly reduce optical power requirements.

REFERENCES

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