SIMULATION AND EXPERIMENTAL STUDY OF PLANAR SLOW-WAVE STRUCTURES ON DIELECTRIC SUBSTRATES FOR MICROFABRICATED TRAVELING-WAVE TUBES

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ABSTRACT

Miniaturized millimetre and THz-band vacuum power amplifiers and oscillators are of great interest for applications in modern high-speed communication systems, radar, security systems, electronic warfare, etc. Planar microstrip slow-wave structures (SWS) on dielectric substrates are very promising for using in traveling-wave tubes and backward-wave oscillators thanks to their high slow-wave factor, which allows low-voltage operation and reduce of size of the tube [1]-[3]. Such SWSs can easily accommodate high-aspect-ratio sheet electron beams, which allows to increase the total output power. In this work, the results of design, simulation and fabrication of V- and W-band planar SWSs on quartz substrate for a low-voltage sheet electron beam TWT are presented.

The SWS circuits were fabricated by technology based on magnetron sputtering of oxygen-free copper on the quartz substrate and subsequent laser ablation [3]. Experimental measurement of the S-parameters reveals good transmission properties. Return loss (S11) does not exceed –10 dB and transmission loss (S21) is about 1.0-1.5 dB/cm in V-band and 5-10 dB/cm in W-band. Numerical simulation of the beam-wave interaction predicts up to 20 dB small-signal gain with 2-3 GHz -3 dB bandwidth and up to 80 W output power at saturation.

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References

[1] G. ULISSE and V. KROZER, “W -Band Traveling Wave Tube Amplifier Based on Planar Slow Wave Structure,” IEEE Electron Device Letters, Vol. 38, No. 1, P. 126-129.
[2] S. WANG and S. ADITYA, “A microfabricated V-shaped microstrip meander-line slow-wave structure,” IEEE Trans. Electron Devices, Vol. 60, No. 3, P. 1251-1256.
[3] N.M. RYSKIN, A.G. ROZHNEV, A.V. STARODUBOV, et al., “Planar microstrip slow-wave structure for a low-voltage V-band traveling-wave tube with a sheet electron beam” IEEE Electron Device Lett. 2018. Vol. 39. No. 5. P. 757-760.