A 0.22 THz Sine Waveguide Traveling-wave Tube

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***Abstract*—A 0.22 THz sine waveguide TWT is designed to develop the high power terahertz radio source. The simulation results reveal that with the sheet electron beam parameters of 20.8-kV and 100mA, the maximum output power and interaction efficiency can reach 90.59W and 4.36% , respectively.**

I. INTRODUCTION

RECENTLY, a novel slow wave structure (SWS) called sine waveguide is presented to develop the high power terahertz radio source[1]. In the G-band, the applications such as high resolution imaging, diagnostics systems, high-data-rate communications, and space applications has been already demonstrated. In this report, the high frequency system of 0.22THz sine waveguide TWT including input/output coupler, connectors, and attenuator is designed appropriately.

II. SINE WAVEGUIDE TWT PERFORMANCE

Fig.1 shows the dimensional structure parameters of sine waveguide SWS. The dimensional parameters are optimized by the Eigenmode solver in the 3-D electromagnetic simulation software Ansoft HFSS[2], and they are shown in the Fig.1.

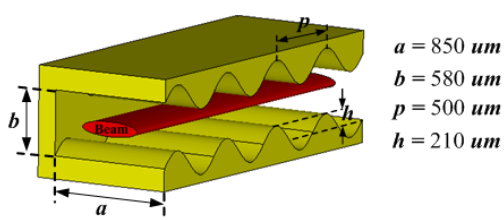

Fig. 1. The solid model and dimensional parameters of the sine waveguide SWS.

The high frequency parameters are shown in Fig.2. The synchronous beam voltage is optimized to 20.8 kV, and the interaction impedance is computed on the central axis of the beam tunnel. The losses of sine waveguide SWS are less than 0.2868 dB/period ,and the conductivity is set as 2.2×10^7 S/m.

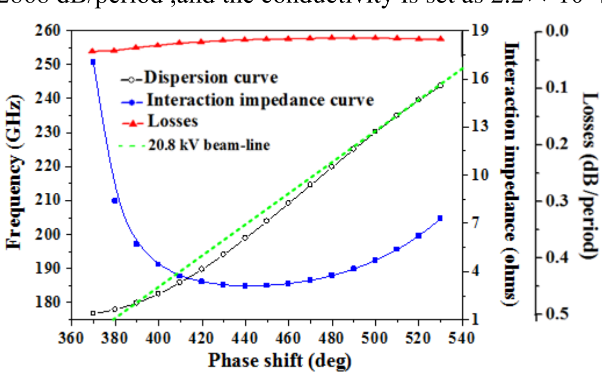

Fig. 2. Dispersion curve, interaction impedance, and losses as a function of the normalized phase shift.

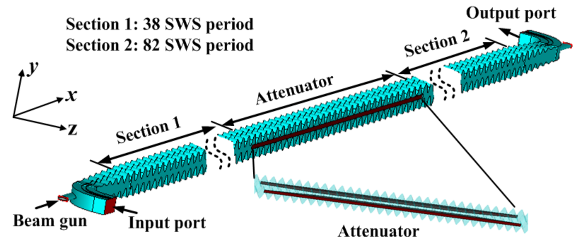

Fig. 3. Sketch of the interaction simulation model

The input/output coupler, connectors, and attenuator of 0.22-THz sine waveguide TWT is demonstrated in Fig.3. The beam-wave interaction model has been built up using the CST Microwave Studio and CST particle Studio, which is shown in Fig.3. The input/output coupler is the ridge waveguide whose H plane bends 90 degree gradually. And the elliptical electron beam channel through the input/output coupler is designed to reduce the reflection. The connectors between the main SWS and the input/output coupler are the transitions. The main sine waveguide SWS is divided into two sections separated by an attenuator to reduce the oscillation and to generate the steady output power. The length of each section is 38 periods and 82 periods respectively, and the length of attenuator is 30 periods. The attenuator is designed as shown in the inset of Fig.3, and it includes one uniform section and two tapered sections. The length of the uniform section and tapered section is 18 periods and 6 periods, respectively.

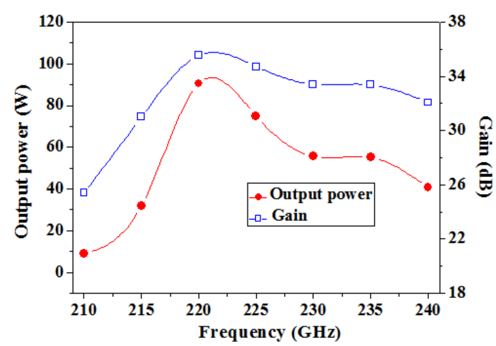

Fig.4. Plot of output power and gain of sine waveguide TWT versus frequency

An elliptical sheet beam (370 um×90 um) of 20.8kV and 100mA is assumed in the calculation. Then, we apply an input signal with a peak power of 25 mW. The sine waveguide TWT can produce several tens of watts ranging from 210GHz to 240 GHz as shown in the Fig.4. The maximum output power can achieve 90.5W corresponding to the gain 34.719dB.

III. SUMMARY

A 0.22THz sine waveguide TWT is designed completely by the simulation method.

IV. ACKNOWLEDGEMENTS

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