Design and Fabrication of High Gradient Accelerating Structure Prototype at 36.5 GHz*

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Abstract

Disc loaded waveguide (DLWG) at 36.5 GHz was chosen as prototype of accelerating structure for reaching gradient up to 100 MV/m. The results of calculation and fabrication of DLWG cells are given. The technique of matching DLWG to input and output couplers is described.

I. INTRODUCTION

This paper describes results of design and fabrication of accelerating structure to reach the gradient up to 100 MV/m at 36,5 GHz. We used the results of the investigations, carried out at CLIC [1], to choose DLWG as accelerating structure.

II. DESIGN AND FABRICATION DLWG CELLS

DLWG cell is shown in Fig.1. The calculations were carried out by PRUD-0 [2]. The results of calculations are presented in Table 1.

Table 1
Structure parameters at 36.5 GHz

Parameters	Value
Phase velocity β_{ph}	1
Quality factor Q	4140
Shunt impedance r, MΩ/m	120
Group velocity b_g	0.074
Section length l, mm	164.1
Cells per section N	60
Iris aperture over wavelength α/λ	0.2
Travelling wave mode	$2\pi/3$

The level of tolerances, required on main cell dimensions in order not to exceed the frequency error ±5 MHz must be ±0.001 mm. Theoretical estimates show that for copper at 36.5 GHz a surface finish of $R_a \le 0.04$ μm is required to a obtain 90% of the theoretical Q value. The copper cells were machined to required tolerances and surface finish $R_a \le 0.160$ μm on precision diamond tool lathe with using special developed technology. After fabrication the frequency of each cell was measured by resonance method. The five cells of seventy five cells were incorrect. After this, the frequencies of resonance stacks of three, six, nine, twelve cells were measured. The dispersion curve is shown in Fig. 2.

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III. MATCHING OF COUPLERS TO DLWG STRUCTURE

The problems of matching couplers to DLWG structure with large cell-to-cell coupling are described in [3]. The main difficulty is to get first matched coupler. We choose the coupler of SLAC-type with off-axis iris of coupling and off-axis cutoff frequency hole for vacuum pumping (Fig.3).

The matching was made in several stages.

1. The coupler with variable dimension $2b$ was developed.

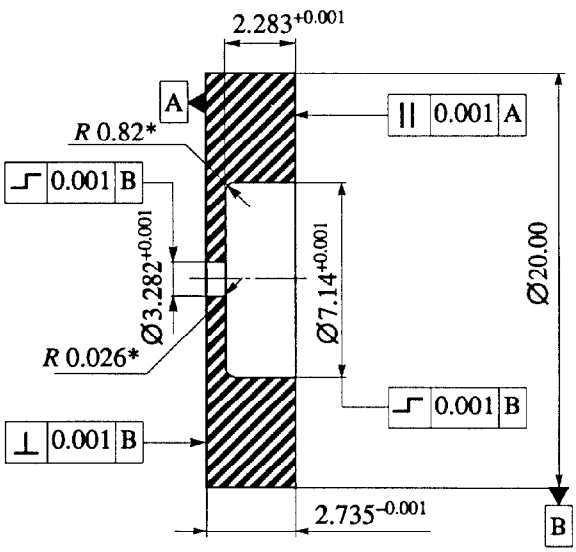

Figure 1. DLWG cell.

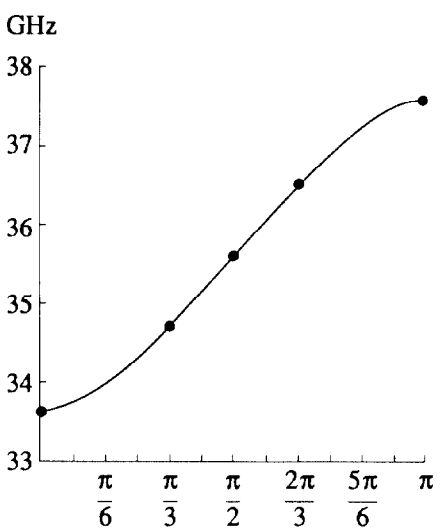

Figure 2. Dispersion curve.

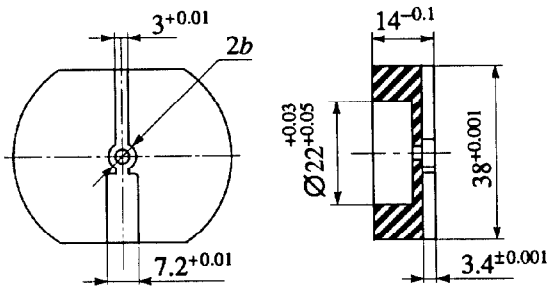

Figure 3. Coupler for DLWG.

2. Two "variable" couplers were matched to twelve cells of DLWG by increasing iris of coupling with rectangular waveguide (7.2 × 3.4 mm) until VSWR of input coupler ≤1.02.

3. Two working couplers were matched successively as input couplers, when the "variable" matched coupler was connected to output. The procedure of determination VSWR of input coupler was to remove cells (each cell removed changes phase by $2\pi/3$ and 3 impedance points are sufficient to cover 2π) and to measure VSWR [3].

Sixty cells of DLWG were assembled in vacuum tube with two working matched couplers and preliminary vacuum pumping was made.

CONCLUSION

DLWG for operation in the $2\pi/3$ mode at 36.5 GHz was made. VSWR of input coupler at operating frequency was 1.02. Calculations show, that accelerating gradient will be 100 MeV/m at input power about 41 MW.

REFERENCES

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