Theoretical Study of Phase and Amplitude Characteristics of Microwave Coplanar Delay Line Containing Thin Ferroelectric Layer

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Introduction: It was shown in [1] that it is possible to create the microwave delay line controlled by voltage by means of using a thing film of ferroelectric material. Our aim was to estimate controllability of coplanar delay line. Relative permittivity of the film changed significantly under voltage applied to

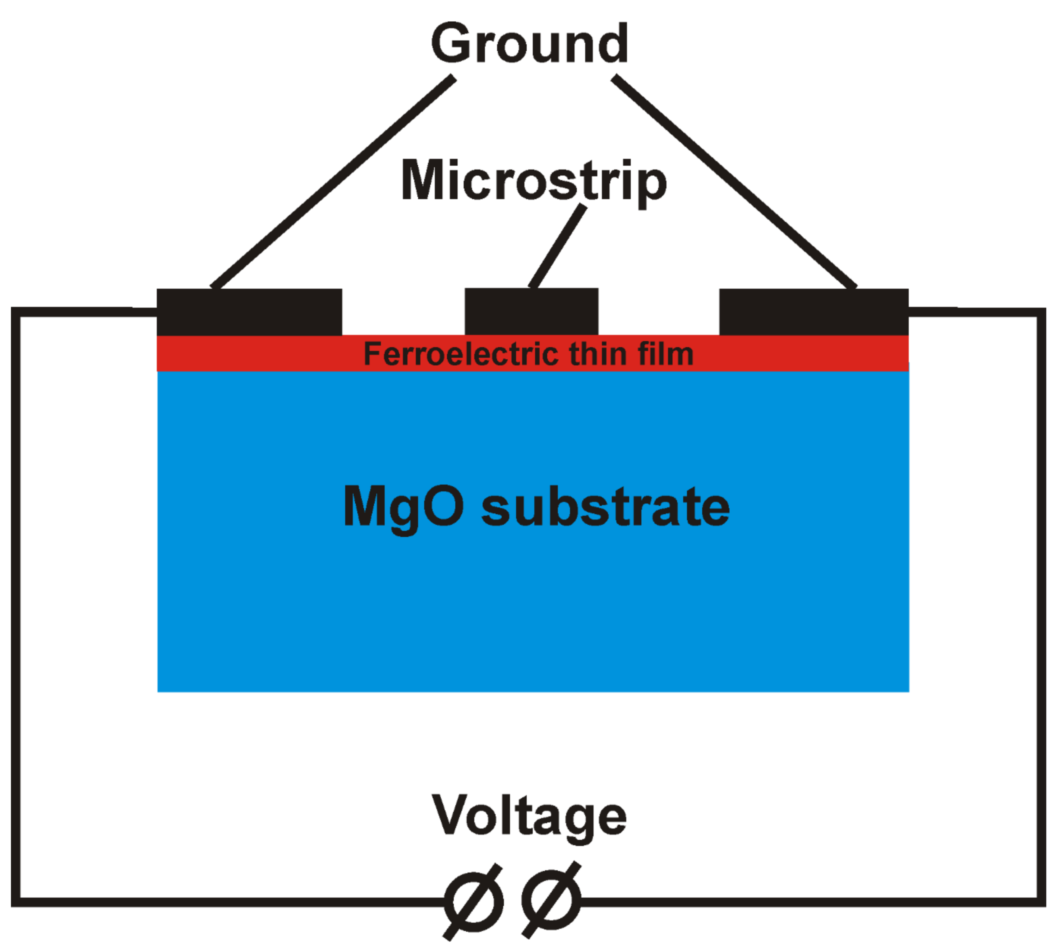

Figure 1. Microwave coplanar delay line with thin ferroelectric film

the ground (Fig.1). It will effect on velocity of electromagnetic wave changing the delay time.

Computational Methods: We computed electric field of electromagnetic wave that propagates alone the coplanar delay line using the environment of 3D modeling in Comsol, RF module, Frequency Domain. Our line delay was surrounded by a sphere on which were set the scattering boundary conditions. To enter the radiation into the delay line, we used lumped port. We carried out the calculations for the different turns undercuts geometry. Shown in Figure 2 is the microwave coplanar delay line metallization for the rounded undercuts.

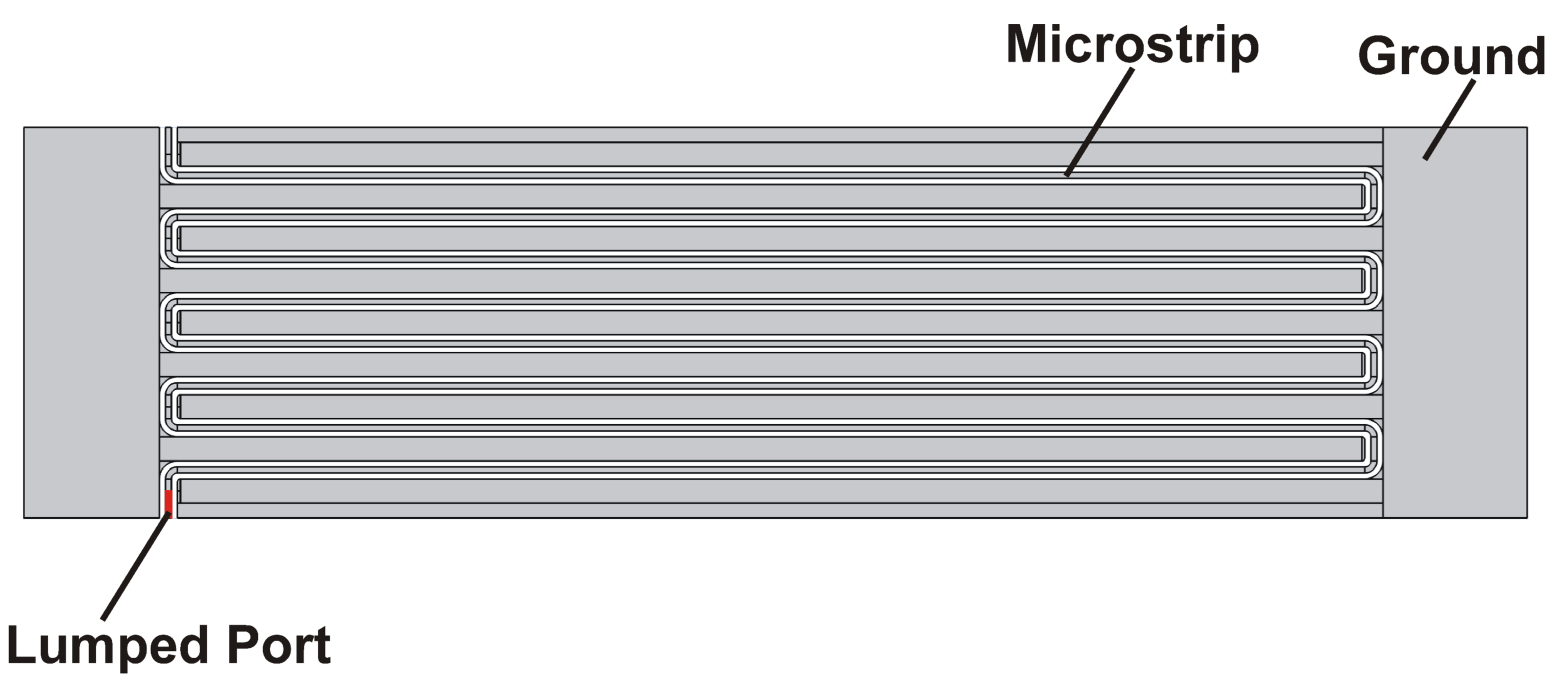

Figure 2. Microwave coplanar delay line metallization

Results: The parameters of the delay line and the frequency are shown in Table 1. The most important results are presented in Figures 3-5. We can observe that velocity of electromagnetic wave change significantly with film relative permittivity.

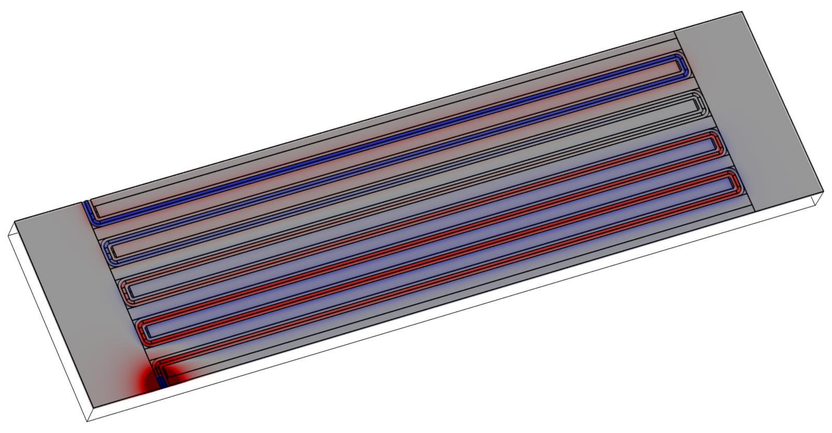

Figure 3. E3 component ε= 600

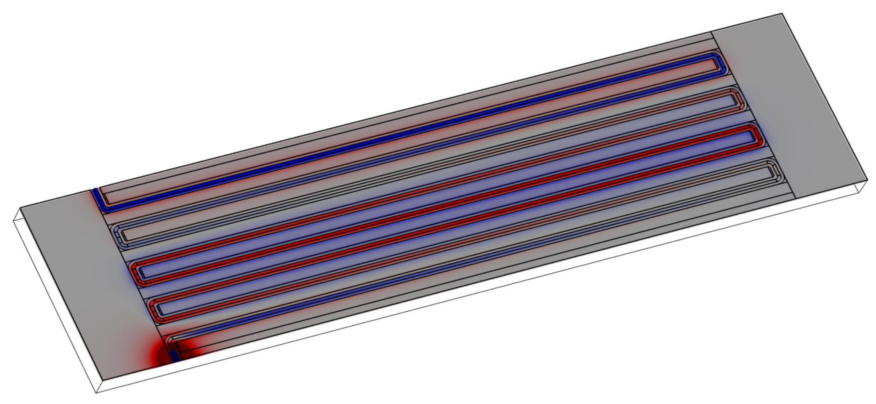

Figure 4. E3 component ε= 2000

Variable	Value	Units
Substrate relative permittivity	9.7	
Film thickness	30	nm
Metal thickness	1	μm
Frequency	10	GHz
Substrate sizes	500 X 130X20	μm^3

Table 1. Parameters of structure

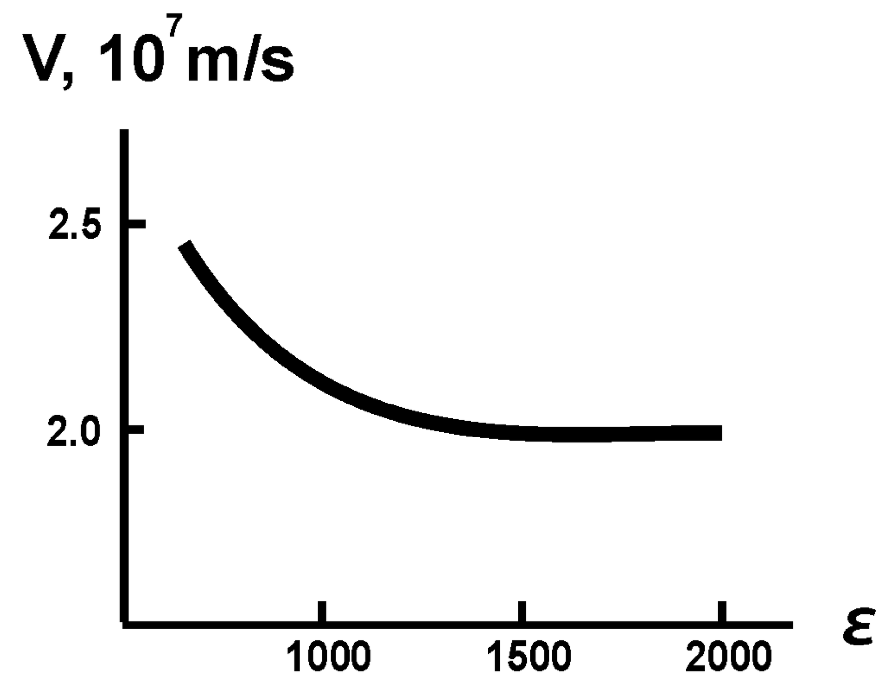

Figure 5. Velocity dependence upon film relative permittivity

Conclusions: The results of the calculations show that the time delay under external field can be changed by 20%. It provides to create the delay line controlled by voltage. Creating the delay line with delay time of 50 ns we can obtain the time tuning up to 10 ns.

References:

1.S. Gevorgian, Ferroelectrics in Microwave Devices, Circuits and Systems: Physics, Modelling, Fabrication and Measurements , Springer, P. 394, pp.181-183 (2009)