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3D COPLANAR WAVEGUIDE STRUCTURES ON GaAs/Si SUBSTRATES FOR MMIC APPLICATIONS

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3D coplanar waveguide structures for MMIC applications on both Silicon and Gallium Arsenide substrates are proposed. Their performances are investigated with electromagnetic simulations and their results are compared in order to find the best possible structure.

1. Introduction

Coplanar waveguide structures are being used extensively in MMICs. In this paper coplanar waveguide structures on GaAs and Si substrates are proposed. These dielectric substrates form the base of these proposed structures. The multilayer CPW structures allow a higher packing density, which is a very important factor in microwave circuits since they need to be very small. The problem of current crowding at the conductor edges is also overcome by employing a V-shaped signal conductor, with ground planes that overlap on different metal levels. These proposed closed structures, also reduce the radiation problem from the signal and ground conductors in the top layer. The performance of these structures can be investigated and compared in order to find the best dielectric substrate for these lines. Also in multilayer CPW structures, the performance can be investigated further more by employing a mixture of air and polyimide instead of a pure polyimide in between the metal layers to see which structure has the best performance. HFSSTM software is used here in order to investigate the performance of CPW structures.

2. Proposed Configuration

The proposed multilayer CPW structure consists of 3 layers on both Si and GaAs dielectrics, which have a width of 600 μm and a length of 1000 μm . Si and GaAs substrates are 400 μm thick and their relative dielectric constants are 11.9 and 12.85 respectively. Top section (M3), is made from a 3 μm thick metalization layer and the space in between this layer and the metallic box is filled with air. The thickness of air is 50 μm . The bottom two sections (M1 and M3) are made up of 1 μm thick metalization layers. In each of the GaAs and Si structures, the space in the bottom two sections is filled, first with polyimide layers, with a thickness of 4 μm and then a mixture of air which has a thickness of 3 μm and polyimide with a thickness of 1 μm . The relative dielectric constant of the polyimide is 3.4. The cross section of these structures are shown in Figures 1-4. Figure 5 and 6 show the cross sections of the conventional CPW structures on GaAs and Si substrate respectively. The structure consists of a single layer, with a length of 1000 μm . The metallizations are 1 μm thick. GaAs and Si substrates are 400 μm thick, 600 μm wide and have a dielectric constants of 12.85 and 11.9 respectively. The metallic enclosure is filled with air and has a height of 50 μm . The walls of the enclosure are 1 μm thick.

3. Results

The corresponding S12 responses of the proposed CPW structures are shown in figures 7-12. As we can see from the performances, GaAs serves as a better dielectric material since the insertion loss is lower than when Si is used. Also in multilayer structures, when a mixture of air and polyimide is used instead of pure polyimide in the bottom two sections, the response is better, since the dielectric loss is reduced, see Figures 9 and 10. Photomicrograph of fabricated monolithic metallic enclosure on GaAs substrate (100 x 20 microns) is shown in figure 13.

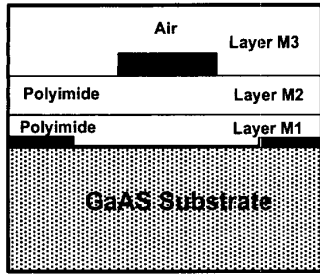


Fig. 1. Cross section of shielded CPW transmission line on GaAs substrate.

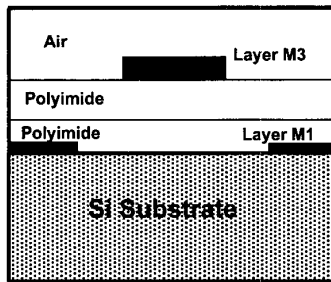


Fig. 2. Cross section of shielded CPW transmission line on Si substrate.

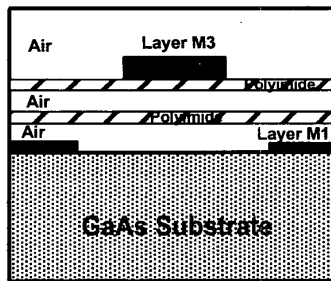


Fig. 3. Cross section of shielded and membrane_mounted CPW transmission line on GaAs substrate.

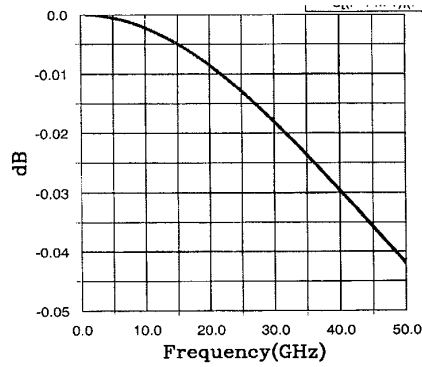


Fig. 7. Simulated S12 response for shielded CPW line on GaAs Substrate.

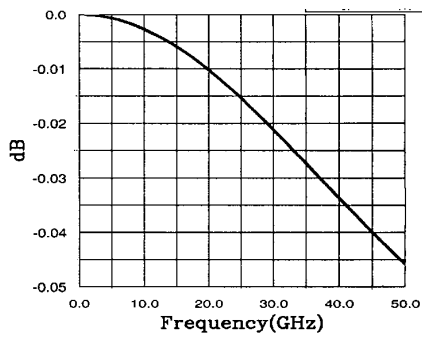


Fig. 8. Simulated S12 response for shielded CPW line on Si substrate.

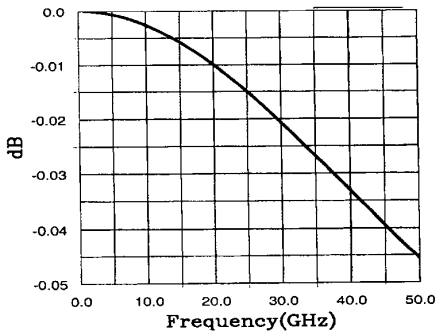


Fig. 9. Simulated S12 response for shielded and membrane_mounted CPW line on GaAs.

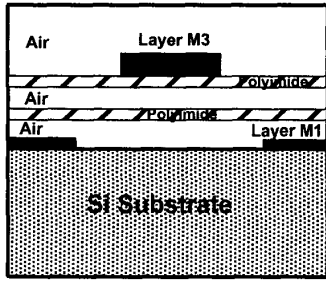


Fig. 4. Cross section of shielded and membrane_ mounted CPW transmission line on Si substrate

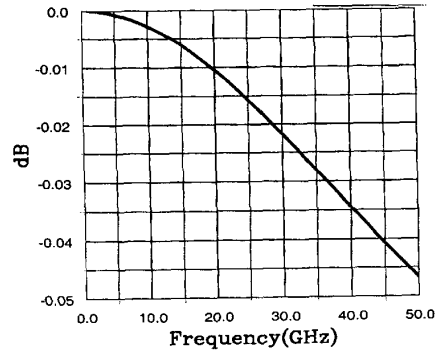


Fig 10. Simulated S12 response for shielded and membrane_ mounted CPW line on Si substrate.

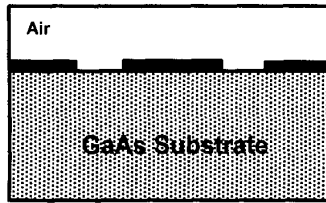


Fig. 5. Cross section of shielded conventional CPW transmission line on GaAs substrate.

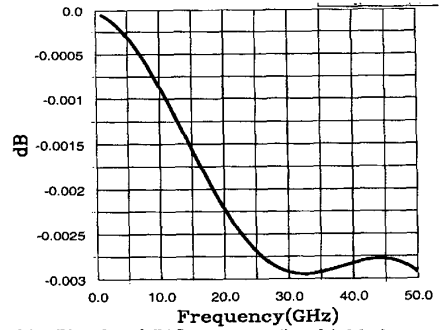


Fig. 11. Simulated S12 response for shielded conventional CPW transmission line on GaAs substrate.

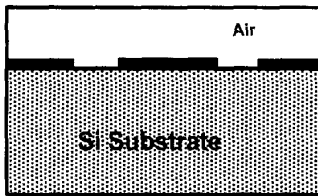


Fig. 6. Cross section of shielded conventional CPW transmission line on Si substrate.

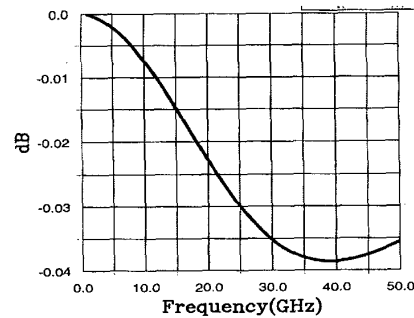


Fig. 12. Simulated S12 response for shielded conventional CPW transmission line on Si substrate.

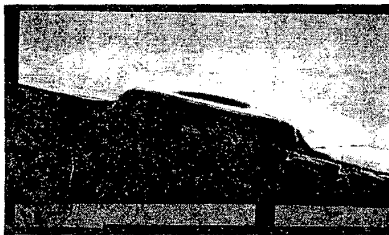


Fig. 13 Photomicrograph of fabricated monolithic metallic enclosure on GaAs substrate (100 x 20 microns).

Conclusion

In CPW structures, by investigating the proposed structures using electromagnetic simulation, it is found that GaAs serves as a better dielectric substrate since the insertion loss is reduced. The results also show that in multilayer CPW structures, by using a combination of polyimide and air, the dielectric losses are reduced, so we have a better response. Agilent HFSS was used for electromagnetic simulation of the proposed structures.

Acknowledgement

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