Micro machined Multilayered Miniaturized Filter

Mariselvam.V, S.Meivel, M.Sivadharsini

***Abstract*: To obtain high performance in Stepped impedance filters it require large low to high impedance ratios. High ratios results in filter having large step discontinuities can be reduced there by introduce losses. Miniaturized filters on micromachined multilayered substrates are capable of addressing the above issues and realize optimal performance filters. In this paper a micromachined multilayered filter is designed on a multilayered substrate with silicon (εr =11.7) and silicon dioxide (εr =3.9) and simulated in CST software. The microwave performances of the filter show less than 1dB insertion loss and enough stop band rejection for W-band application.**

***Index Terms*— Low pass filters, Micromachining, Microwave Filters.**

I. INTRODUCTION

Efficient frequency spectrum usage is required by a variety of communications related applications (e.g., wireless systems, collision avoidance radars, etc.) and demands the development of high-performance filters for frequency selectivity [1].The need for highly portable and inexpensive components encourages the development of planar designs on high-index semiconductor materials that offer low-cost manufacturing capability. insertion loss and low unloaded quality factors Qo are the factors affecting the performance of filter applications[2]. Thin dielectric membranes have proven to have good performances for millimeter wave applications, in Micro-machined planar filters[1]–[3]. Large high-to-low-impedance ratios for planar filter designs use equivalent transmission-line representation for inductive and capacitive filter elements. High dielectric-constant semiconductor materials (e.g., GaAs and Si) offer compactness, in the stepped impedance filter, it can suffer from shallow roll off and poor attenuation in the stop band due to impedance range limitations that preclude achieving large high-to-low-impedance ratios. In this, a silicon (Si) wafer is micromachined to form a "synthesized substrate" that can minimize low impedance and maximize high-impedance values. Preliminary findings of this micromachining approach have been demonstrated.

Similar designs have been shown in [2], where a BCB polymer membrane technology has been used as an alternative method to semiconductor membrane processing techniques. In this an emphasis is placed i.e. the use of bulk Si micromachining to achieve optimum filter design. Two approaches have been investigated for the development of high-performance micromachined low-pass filters. The first approach attempts to further decrease the low-impedance value of the microstrip line by thinning the substrate locally; micromachining an air cavity locally to reduce the effective dielectric constant. For comparison purposes, a stepped-impedance filter is been realized on both conventional and synthesized substrates. [1]

The filter performance can be improved by using Micromachining techniques, the technique consists of removing the dielectric material up to a thin membrane that suspends the planar filters. [2]

The filters are packaged in a micromachined cavity.

The combination of bulk micromachining by the removal of substrate and self packaging that reduces radiation loss both into air and dielectric substrate modes, and also greatly reduces ohmic loss for very wide microstrip lines. The micromachining techniques have been successfully applied to K- and W-Band microstrip membrane supported filters [3], [4].

II. MICROMACHINED MULTILAYERED FILTERS

A 20Ω low impedance section requires a very large width and a 100Ω high impedance section may require a very small width. The ratio is1:38 of the width of height to low impedance section is as great as resulting in large step size and increased step discontinuity losses. Reducing the effective dielectric constant of the substrate below the high impedance section increases the impedance value easily. Complex mechanical structures require the use of multilayered substrates for specific applications [6].

Micromachining of substrates have limitations to the mechanical stability of the structure. The use of multilayered substrates can be a suitable alternative and allows higher degree of design freedom. The bonding of the two or more wafers using wafer bonding techniques [13] is used to obtain Multilayered Substrate.

A. Design of Low Impedance Section

The multilayered substrate has micromachined 300µm in thickness beneath the low impedance section to a height of 100µm, by removing the entire silicon dioxide layer as shown in fig.1.This reduction in the distance between the conductor and ground plate results in miniaturization of the band pass filter low impedance section.

Revised Manuscript Received on April 05, 2019.

V. Mariselvam, Electronics and Communication Engineering, M.Kumarasamy College Engineering, Karur, Tamil Nadu, India. (E-Mail: mariselvamv@gmail.com)

S. Meivel, Electronics and Communication Engineering, M.Kumarasamy College Engineering, Karur, Tamil Nadu, India. (E-Mail: meivels.ece@mkce.ac.in)

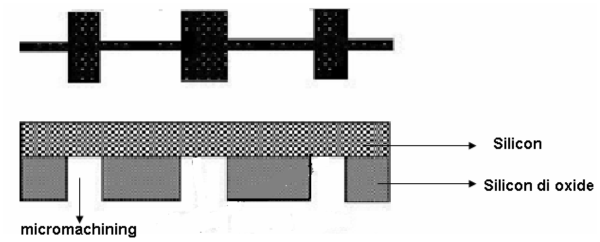

FIG 1. Top and side view of the Micromachined Band pass filter

B. Dimensions of the filter structure

Filter section	Length (µm)	Width (µm)
L1(H)	547	135
L2(L)	1045	182
L3(H)	512	129
L4(L)	1046	182
L5(H)	499	146
L6(L)	1046	182
L7(H)	512	119
L8(L)	1046	182
L9(H)	547	135

H-high impedance section L-Low impedance section

C. High Impedance Section Design

The two different dielectric constantsas a multilayered substrate is used to obtain High impedance values. When 20µm thickness high index silicon is bonded to a 180µm low index silicon dioxide, the effective dielectric constant reduces from an initial value of 11.7 to a value of 6.5.

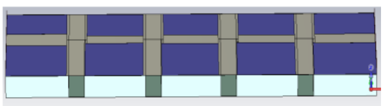

FIG 1. Top and side view of the Micromachined Band passFilter using 3D CST software

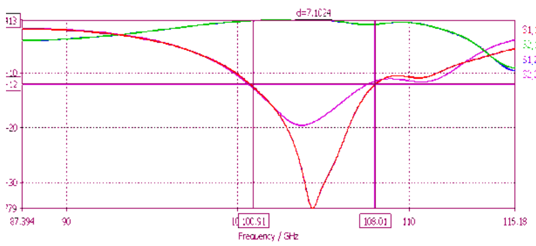

FIG 2. Response of the 3D model Micromachined Bandpass filter using CST software

III. FILTER SYNTHESIS

The length and width of the filter is 3336X1046 (µm) as in Fig.2. The filter low impedance L21 is of 166X613 (µm).

IV. RESULTS AND DISCUSSIONS

The band pass filter of cutoff frequency of 104 GHz with band width of 8.23 GHz from 100.0 to 108.23 GHz is designed and simulated in a 3D software CST The length and width of the filter is 3336 X1046 (µm) which is very small in size.

V. CONCLUSION

A two layer Band Pass filter at a frequency of 104 GHz is designed using Computer Simulation Technology (CST) 3D software. Performance comparison shows that the two layer structure gives improved loss characteristics.

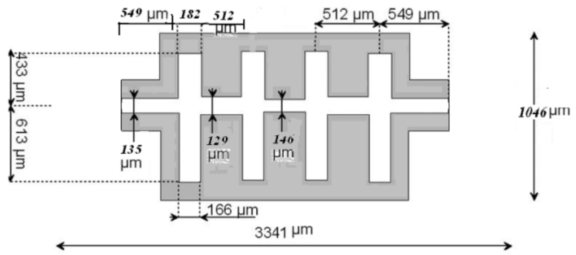

Fig 3. Layout of the proposed filter

REFERENCES

1. Micromachined Filters on Synthesized Substrates Rhonda Franklin Drayton, Member, IEEE, Sergio Palma Pacheco, Jianei Wang, Jong- Gwan Yook, Member, IEEE,and Linda P. B. Katehi, Fellow, IEEE IEEE TRANSACTIONS ON MICROWAVE THEORYAND TECHNIQUES, VOL. 49, NO. 2, FEBRUARY 2001
2. C. Y. Chi and G. M. Rebeiz, “Conductor loss limited stripline resonator and filters,” IEEE Trans. Microwave Theory Tech., vol. 44, pp. 626–629, Apr. 1996.
3. S. V. Robertson, L. P. B. Katehi, and G. M. Rebeiz, “Micromachined self-packaged W-Band bandpass filters,” in IEEE MTT-S Symp. Dig., 1995, pp. 1543–1546.
4. Design of Narrow-Band DBR PlanarFilters in Si–BCB Technology For Millimeter-Wave Applications Gaëtan Prigent, Eric Rius, Member, IEEE, François Le Pennec, Sandrick Le Maguer, Cédric Quendo, Gonzague Six, and Henri Happy, Member, IEEE
5. R. F. Drayton, S. Pacheco, J.-G. Yook, and L. Katehi, “Micromachinedfilters on synthesized substrates,” in IEEE MTT-S Int. Microwave Symp. Dig., 1998, pp. 1185–1188.

Published By:
Blue Eyes Intelligence Engineering
& Sciences Publication