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Phase Linear・Flat Wide Band・Low Loss Filters Using New Configuration of Unidirectional Up-Chirp and Down-Chirp Dispersive Inter Digital Transducers

新構造一方向性分散型すだれ状電極を用いた位相直線・広帯域角形・低損失フィルタの解析

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1. Introduction

In order to obtain the high performance Surface Acoustic Wave (SAW) devices, it is very important for the intrerdigital transducer (IDT) to be made the unidirectional ones (UIDT) together with SAW materials[1]. Especially mobile communication and UWB communication systems require the phase linear･wide band･low-loss filters at GHz-ranges. We proposed new UDT of the SiO_2 and TeO_2 very thin grating films with 1.0dB insertion loss at 2GHz-range and unidirectional dispersive IDT (UDIDT) for the elastic convolvers[2,3]. The dispersive IDTs (DIDT)s with up-chirp or down chirp phase linear characteristics have the flat wide band and sharp cut-off characteristics without amplitude weighting of SinX/X[4]. The transversal types of SAW filters have better power duration of IDT electrode than those of resonator types of filters[5] wihtout phase linear. The phase linear and flat wide band are obtained by combining of up-chirp and down chirp dispersive interdigital transducers. Also, low loss filters with about 0dB insertion loss are obtained by using the unidirectional up-chirp DIDT (UUDIDT) and unidirectional down-chirp DIDT(DUDIDT). Fan-shape IDT (FIDT) filters have flat wide band with sharp cut-off characteristics. But the FIDT can not use for low-loss filters, because the theoretical minimum insertion loss is about 3.5dB. We proposed the wide band filters combining DUDIDT and UUDIDT using the conventional UDT with the grating thin films. In this case, we could not obtained the low loss results.

In this paper, the theoretical results of phase linear, flat wide band and low loss filters using combining new DUDIDT and UUDIDT are described. DUDIDT and UUDIDT are obtained by using new cofiguration of Dispersive IDT. The large unidirectinalities of DUDIDT and UUDIDT are obtained by using the change of the electrode width and thickness, and open and short -circuit electrode as the reflectors.

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2. New configuration of DUDIDT and UUDIDT

Figure 1 shows the dispersive UDT filters using the thin film gratings. In this case, photo-mask alignments are required.

Figure 2 shows the new configuration of DUDT filters. The substrates are 128 °Y-X $LiNbO_3$[6]. The film thickness of Al thin film are H/λ=0.05. The electrode widths of down direction are λ/8 and λ/8 floating electrodes. The reflectivities (r) per λ of the electrodes are r=0.05 with the large refrectivities. The electrode widths of up direction are 3λ/8 only. The reflectivities per λ of electrodes are r=－0.05 with the large refrectivities with a good unidirectionalities.

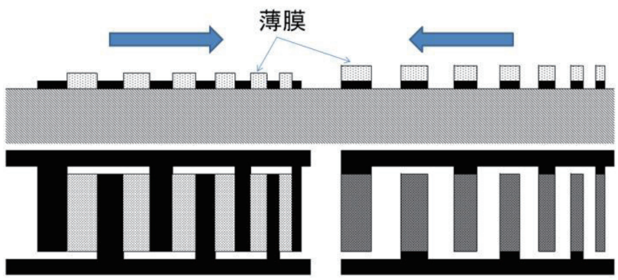

Fig. 1 Dispersive unidirectional transducers with dielectric thin film gratings

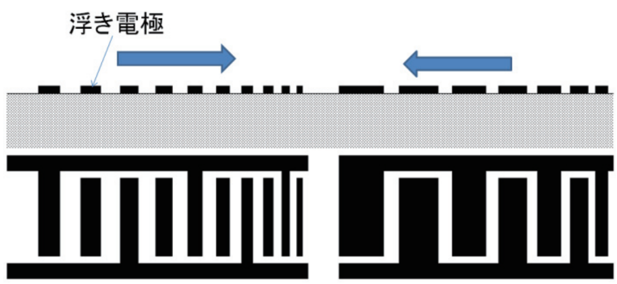

Fig. 2 New dispersive unidirectional transducers of λ/8 electrodes with floating λ/8 and 3λ/8 electrodes

3. Frequency characteristics of new filters

Figures 3 shows the directivity of the down-DUDT with N=100. The large directivity of 13dB are obtained.

Figures 4 shows the directivity of the up-DUDT with N=100. The large directivity of 15dB are obtained.

Figure 5 shows the filter characteristics combined the DUDIDT and UUDIDT with the uniform aperture. The very low loss results with 0.5dB are obtained with a little poor side lobe suppressions.

Figure 6 shows the filter characteristics combined the DUDIDT and UUDIDT with the distance weighting UDT electrodes. The very low loss results with 0.5dB are obtained with good side lobe suppressions.

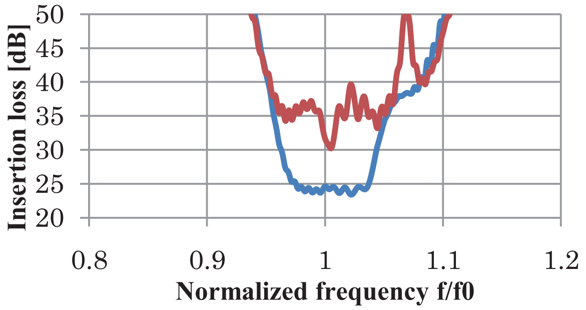

Fig.3 The directivity of the down-DUDT with N=100

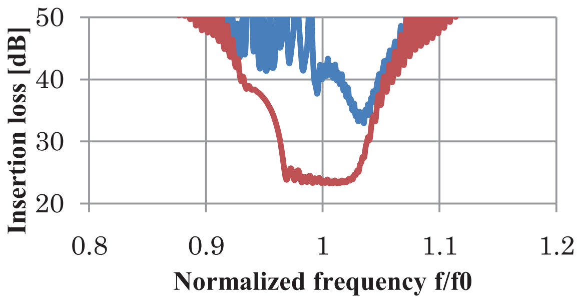

Fig.4 The directivity of the up-DUDT with N=100

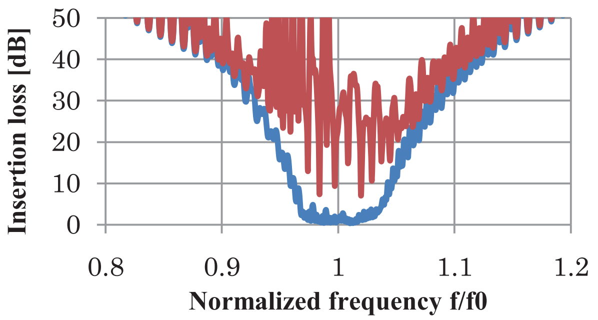

Fig.5 The filter characteristics combined the DUDIDT and UUDIDT with the uniform aperture

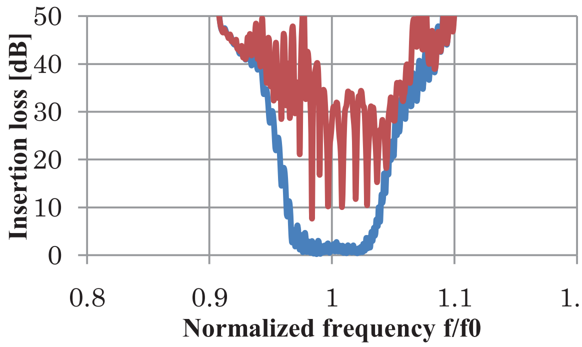

Fig.6 The filter characteristics combined the DUDIDT and UUDIDT with the distance weighting UDT electrodes

4. Conclusions

We proposed the new configuration of dispersive unidirectional IDT. The large unidirectinalities of DUDIDT and UUDIDT are obtained by using the change of the electrode width and thickness, and open and short -circuit electrode as the reflectors. The directivities of dispersive IDT are obtained about 40dB for the numbers of IDT-pairs of 100 and about 0.5 dB insertion loss filters with band width of 10% are obtained. We are now taking the experiments.

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