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BAND STOP FILTER DESIGN IN GHZ REGION USING HYDROGEN BOND FERROELECTRIC LIQUID CRYSTAL

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Abstract - *The discussion in this paper is about absorbing band stop filtering action in GHZ region using HBFLC (Hydrogen Bond Ferroelectric Liquid Crystal). It is necessary to know about the properties of ferroelectric liquid crystals and how it differs from other liquid crystals. Generally, filters like band stop filters will be made using passive components like Resistor, Inductor and Capacitor. The drawback in this process is that we cannot obtain a stable band stop filter action using these passive components. Because the efficiency of these passive components will be varied with respect to the temperature. To overcome this drawback, we are using Optical Filtering technology to obtain a stable band stop filter action at room temperature. The polarization property of the ferroelectric crystal plays an important role in absorbing the band stop filtering action in a liquid crystal. As polarization of the liquid crystals plays an important role in providing the band stop filtering action or any other filtering action, we should provide external electric supply in case of non-ferroelectric liquid crystals. As polarization in ferroelectric liquid crystal happens in the absence of the external electric field it removes the need of additional input thus performing the band stop filtering action in the absence of the external electric field. The spontaneous electric dipole moment of ferroelectric liquid crystal exhibits this property of polarization in absence of an external electric field. This property of ferroelectric liquid crystal removes the dependency on electronic filtering and the problems like temperature and external input dependencies. The Ferroelectric liquid crystal used in our case in Benzyloxy Propionic acid and undecyloxy benzoic acid. The filtering action of the ferroelectric liquid crystal used is improved with the help of graphene and the binders used here is potassium bromide. This liquid crystal optical filter used here is graphene based optical adaptive filter. Potassium bromide plays an important role in binding the liquid crystal with each other while forming a pellet using which we will analyze the band stop filtering action in FTIR (Fourier transform infrared spectroscopy). There are optical filters that are capable of providing band stop filtering action but they can possess it in the presence of passive and active components. The filtering action of the ferroelectric liquid crystal and the parameters used are discussed in this paper.*

Key Words: **Filters, Ferroelectric liquid crystal, Undecyloxy benzoic acid, Benzoic propionic acid, FTIR spectroscopy, Polarization**

1. INTRODUCTION

There are various types of ways for filtering the light. It can be filtered using lumped components, microwave and optical filters. In this project we are using Optical filter for filtering the light in the GHZ region (10 - 80GHZ) using hydrogen bonded ferroelectric liquid crystal. The approach of using Liquid crystal for filtering action is already used in image filtering and in detection of frequency in liquid crystal display. Using same filtering properties for analyzing band stop filtering action. The frequency used here is the frequency in the infrared region. The Hydrogen bond ferroelectric liquid crystal used here is a mixture of Benzyloxy Propionic acid and Undecyloxy Benzoic acid. The liquid crystal display uses polarization for allowing the required range of light thus polarization helps in filtering the unwanted frequency. The polarization property of these ferroelectric crystals plays a major role. The spontaneous electric dipole in ferroelectric liquid crystals provides polarization in the absence of the external electric field thus removes the need of electric field dependency. As it is electric field independent the temperature related problems will be eliminated. Any kind of halogens can be used here as a binder for binding the mixture of benzyloxy propionic acid and undecyloxy benzoic acid. But Potassium Bromide is used here over other halogens as it is inert in the infrared region. The inertness of the Potassium bromide allows us to read the

band stop filtering action in Fourier Transform Infrared Spectroscopy effectively as its response is negligible and can be easily eliminated while analyzing the response. The pellet is prepared with the help of ferroelectric liquid crystal and the binder. The Pellet is prepared with the help of KBr press which will press the mixture of ferroelectric crystal and the binder in the specified force. In our case the applied force is 10w/m. This Pellet is a button shaped solid structure which is used for analysis in an FTIR spectrophotometer. The FTIR spectrophotometer is capable of absorbing the wavelength that is absorbed by the material that is placed for analysis. It produces the IR waves with the help of heating the resistor to 800 degree. The Band stop filter is capable of attenuating the amplitude in between the mentioned cutoff frequency. Here the Band stop filter is used to attenuate the amplitude in the infrared region. The Band stop filter response will be analyzed with wavenumber versus transmittance.

2. LITERATURE SURVEY

2.1 MICROWAVE PHOTONIC FILTER

In this paper they have described the use of microwave photonic filters. The main components used in this photonic filter is optical combs as it used to demonstrate and extract the tunable filter. As the name it is a photonic subsystem which is made exclusively to aimed to carry equivalent task. This type of photonic subsystem mainly designed to normal microwave filters within a particular radio frequency. This filter is been used as a link to bring advantages in supplementary functions like low loss and higher bandwidth.

The optical comb is used in a dispersive way which enables filters to scale to large number of taps. Line to line passing method is used to shape the filter to stop the band with a Nyquist ratio of 5GHz and half of comb repetition. To overcome this draw back we are using low frequency to tune the filter at the particular range for band stop filter.

2.2 TUNABLE FILTER USING HIGH DISPERSION FILTER

In this paper they have used dispersion fiber to tap the delay time which is been promising to use in RF technologies. Dispersion fiber are those fibers which spreads light as it is propagates the light in a well spread manner. Optical delay line is used to perform the fixed time delays. More over optical delay line is used mainly in RF based filters because the RF filter is converted into optical based modulated signal. These kinds of filters are reconfigurable lightweight and compact type of filters. Fiber based delay line will offers large bandwidth and wide range to pass the filter.

This kind of wavelength are tuned in the range +1 or -1 nm which allows several types of configuration. The main outcome of the project is to tap a delay microwave filter using dispersion fiber with tunable delay. But the drawback is a filter basically takes too much time a tune which takes more delay time. More over dispersion fibers gives larger amount of foot print and loss temperature when it is been inserted.

2.3 WDM MICROWAVE FILTERS USING NEGATIVE COEFFICIENTS

In this paper they have used negative coefficients to tune the microwave filter with optical WDM. Optical filter is used to transmit a set of wave length for specific light. It basically selects one region of filter and rejects the other filter. This paper uses multiple optical carriers with coefficients of negative terms and a medium is used in a dispersion manner. This kind of negative coefficients are obtained by using phase inversion in a single electrooptic modulator. A notch filter is used to show the feasibility of the given model. The microwave filter is a kind of electronic filter which is designed particularly to operate a signal in Mhz to Ghz range of frequency.

These filters include some kind of filtering techniques which is used to transmit or receive a signal. In in-coherent system positive co-efficient are used because power is used as positive quantity. The drawback is this type of negative incoherent optical system are very insensitive to environment. Transfer function is very limited in number the negative co-efficient is does not obtain stopband function synthesis.

2.4 PHOTONIC TRANSVERSAL FILTER WITH TAPPED WEIGHTS

In this paper they have used a sinusoidal modulation technique is used for tuning a transversal filter using photonic. This is used mainly to tune optical sources and dispersive elements. Microwave photonic filter allows to process very high frequency signals in the optical domain which leads to exploitation of large bandwidth that will inherit the electromagnetic interference in optical waveform. RF signal process is used predominantly in photonic filtering which are limited in electronic system. Filter reconfiguration is used which deals with the change of shape in electrical response and filter tunability. To obtain high performance filters in a flexible manner we will tune the RF to band stop the filter. The tuning of filter for any type of wavelength is used for combining different types of optical fiber sources.

A particular wavelength is fixed and attached with multiple sources with tuning dispersive devices. FSR tuning is used mainly in the optical fiber technique for changing the time delay with the optical taps. The drawback of this paper is optical filter are highly tunable and fully reconfigurable. When an optical source or tuning devices happens continuously in dispersive way RF tuning is required which leads to main disadvantage. This type of tuning methods main requires optically tunable devices and elements. But this photonic RF tuning is not used which will leads to reconfigure and electrical transfer function.

3. COMPONENTS DESCRIPTION

3.1 FERROELECTRIC LIQUID CRYSTAL

In general, Liquid Crystals have various properties. Here, we are using the optical property of the Liquid crystal for achieving a stable band stop filtering action. Liquid crystals are the state of matter where they exist between liquid and solid crystal state. Liquid Crystals can be rigid like solid crystals as their molecules are arranged tightly like solid also they can flow like liquids.

To obtain a stable band stop filtering action we are choosing Ferroelectric liquid crystals. Yet there are various types of liquid crystals, for achieving band stop filtering action we are choosing Ferroelectric liquid crystals. The main property of the Ferroelectric liquid crystal is the property of Polarization. As we know that Polarization is a property where the center of the positive charge and the negative charge does not coincide making one side of the molecule positive and the other side of the molecule negative. But the thing is that, Polarization comes into effect only after the application of the electric field. In our optical filtering band stop filter we are not going to use electric power. That is we are going to achieve ferroelectric band stop filtering action in the absence of the electric power (i.e.) under zero magnitude condition.

By which we are achieving this with the help of the ferroelectric property of the liquid crystal. The special property of the Ferroelectric liquid crystal is Spontaneous Polarization. Spontaneous Polarization is a property of the ferroelectric liquid crystal where the polarization effect comes into existence even in the absence of an external electric field. Ferroelectric Liquid Crystal is made using two acids namely Benzyloxy Propionic Acid (BPA) and un decyloxy Benzoic Acid (BAO) abbreviated as BPA+9BAO.

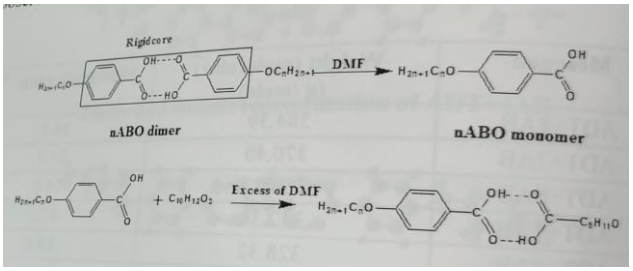

Fig -1 : Synthetic route of Ferroelectric Liquid Crystal

3.2 POTASSIUM BROMIDE

While creating a mixture of liquid crystal (ie.., Benzyloxy propionic acid and Undecyloxy benzoic acid) in a pellet form, these liquid crystals will not get a proper solid structure. So we can add any halogens to make that liquid crystal to form a proper structure. We prefer potassium bromide over other halogens because its output response is inert in infrared region and our liquid crystal response should not be affected by added binders. The output response of liquid crystal formed can be easily analyzed by eliminating the binder's response. Here it is been used as a binder in our project. As it implies salt in nature the appearance of KBr is white in color. The main properties of potassium bromide it is odorless in nature and solubility is very slight in diethyl ether and its molecular mass is 119.002g/mol. We will grind this potassium bromide with our ferroelectric liquid crystal which is made with the help of the acids namely Benzyloxy Propionic Acid (BPA) and Undecyloxy Benzoic Acid (BAO) abbreviated as BPA+9BAO.

The purpose of using Potassium Bromide (KBr) as a binder is that only potassium bromide (KBr) will remain inert in the infrared region. Since we are obtaining the band

stop filter action in the infrared region, Potassium Bromide (KBr) helps a lot by remaining inert in the infrared region.

3.3 KBr PRESS

The KBr press machine plays an important role in the formation of the pellet which is a mixture of ferroelectric liquid crystal and potassium bromide (KBr). Ferroelectric Liquid crystal and potassium bromide (KBr) which is a binder used here is taken in the ratio of 1:10 and grinded well and kept under KBr press. Using Hydraulic press, which gives required amount of force and pressure in the KBr press to form the desired product. The mixture of ferroelectric liquid crystal and potassium bromide (KBr) in the ratio of 1:10 is put under a pressure of 10 tons in the hydraulic press to form the pellet. After the compression of the KBr press, the required Pellet is formed. The output from the KBr press which is the Pellet may be in any geometrical shape.

Fig - 2 : KBr Press

3.4 FTIR Spectroscopy

Fourier Transform Infrared Spectroscopy (FTIR) machine helps in analyzing the output response of the ferroelectric band stop filter. The FTIR machine working is as simple that the FTIR machine has a component called source. This source will emit the infrared waves. The source of the FTIR machine has high resistance. So, whenever the current flows, due to the high resistance, the source gets heated up to above 800 c generating large amount of heat in the form of infrared waves. The emitted Infrared radiations will fall on the pellet which is kept inside the FTIR machine. Then these infrared waves are received by the receiver in the FTIR. The pellet will absorb a wide range of infrared wavelengths. The absorbed wavelength pattern helps in analyzing the molecular composition and structure of the pellet.

4. PROPOSED METHODOLOGY

The first step in our process is the formation of the liquid crystal. Liquid crystals are the state of matter where they exist between liquid and solid crystal state. Liquid Crystals can be rigid like solid crystals as their molecules are arranged tightly like solid and they can flow like liquids. Liquid Crystals have various properties. Here, we are using the optical property of the Liquid crystal for achieving a stable band stop filtering action. To obtain a stable band stop filtering action we are choosing Ferroelectric liquid crystals. In our optical band stop filter we are not going to use electric power. We are going to achieve ferroelectric band stop filtering action in the absence of the electric power (i.e.) under zero magnitude condition. This we are achieving this with the help of the ferroelectric property of the liquid crystal. The special property of the Ferroelectric liquid crystal is Spontaneous Polarization. Spontaneous Polarization is a property of the ferroelectric liquid crystal where the polarization effect comes into existence even in the absence of an external electric field. Ferroelectric Liquid Crystal is made using two acids namely Benzyloxy Propionic Acid (BPA) and Undecyloxy Benzoic Acid (BAO) abbreviated as BPA+9BAO.

The next step in our process is using potassium bromide (KBr) as a binder along with our ferroelectric liquid crystal. The purpose of using Potassium Bromide (KBr) as a binder is that only potassium bromide (KBr) will remain inert in the infrared region. Since we are obtaining the band stop filter action in the infrared region, Potassium Bromide (KBr) helps a lot by remaining inert in the infrared region. Because later to get the stable band stop filter we will subtract the output response of the potassium bromide with the output response of the pellet formed which is a mixture of ferroelectric liquid crystal and potassium bromide (KBr).

Then we are going to form the pellet through which we are going to get the output response in the Fourier transform infrared spectroscopy (FTIR) machine. To form the pellet we are using a machine named KBr press. The KBr press machine plays an important role in the formation of the pellet which is a mixture of ferroelectric liquid crystal and potassium bromide (KBr). Ferroelectric Liquid crystal and potassium bromide (KBr) which is a binder used here is taken in the ratio of 1:10 and grinded well and kept under KBr press. Using Hydraulic press, which gives required amount of force and pressure in the KBr press to form the

desired product. The mixture of ferroelectric liquid crystal and potassium bromide (KBr) in the ratio of 1:10 is put under a pressure of 10 tons in the hydraulic press to form the pellet. After the compression of the KBr press, the required Pellet is formed. The output from the KBr press which is the Pellet may be in any geometrical shape. The final step in our process is to analyze the output response by keeping the pellet formed in the Fourier Transform Infrared Spectroscopy (FTIR) machine.

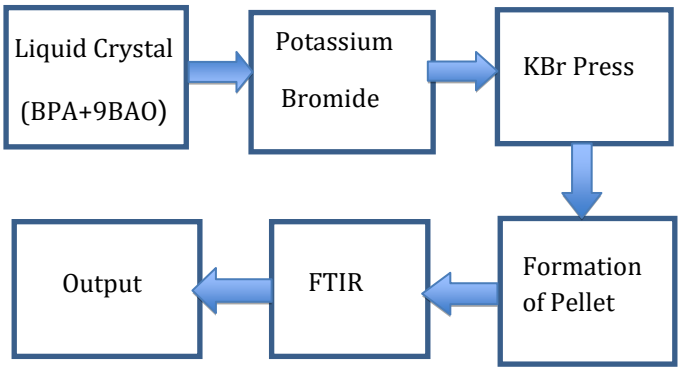

Fig – 3: Block Diagram

5. OUTPUT

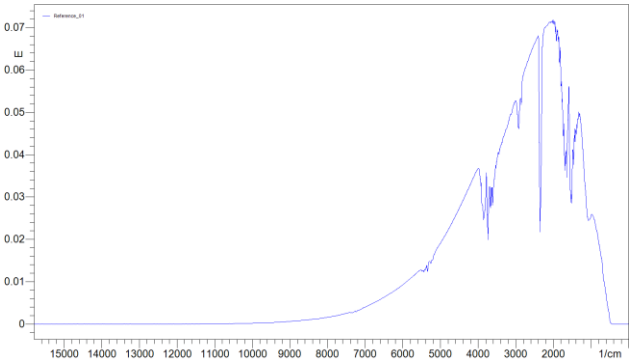

Fig – 4: Output

6. CONCLUSION

In this paper we have undergone the implementation of band stop filtering action in Hydrogen Bonded Ferroelectric liquid Crystal. The ferroelectric liquid used for analyzing band stop filtering action does not require an external electric field for polarization thus removes the problems related to performance issues due to room temperature. The obtained ferroelectric liquid crystal provides the same band stop filtering response irrespective of different environmental conditions thus works efficiently. This ferroelectric Optical filtering techniques can be used to perform any kind of filtering action in our paper we have analyzed only for band stop filters. The Band stop filter response in wavenumber versus transmittance is obtained and validated with respect to the band stop filter response with other kinds of Optical filter that uses external electric fields for polarization.

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