Application of Taguchi Method to Determine Exact Thicknesses of a Stacked Dielectric Bandstop Filter

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There is a growing interest in Terahertz (THz) due to its inherent benefits in imaging, spectroscopy, communications, and security [1]. Design and fabrication of key THz components such as filters becomes challenging due to the associated small wavelengths which in turn requires tight tolerances. This presentation for the first time uses Taguchi method to optimize THz circuits. An example of an interference filter will be presented here.

An interference bandstop filter is a design which gives a bandstop response due to the stacking of quarter wavelength long layers of alternating high and low dielectric constant films [2, 3]. At THz range, such a design will have very tight tolerances towards deviations in the thicknesses of the stacked layers, due to the small wavelength. Even small variations in the thickness of the stacked layers would give a response different from the original design. Figure 1 below shows the difference between simulated and measured transmittance for a 9-layer (5 high dielectric constant layers and 4 low dielectric constant layers) stacked dielectric interference type bandstop filter with the centre frequency at 312GHz. The simulation was done by using a Rigorous Coupled Wave Analysis (RCWA) code [4]. The major cause for the deviation in response is due to different thicknesses of the layers from those specified.

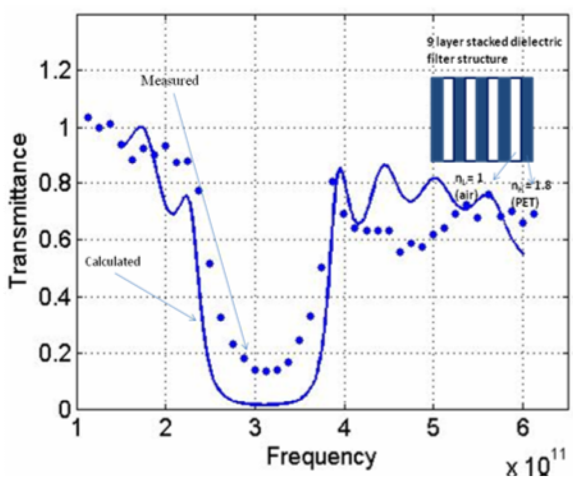

Figure 1. Measured and Simulated Results of a Interference THz Filter

This paper will use Taguchi method of optimization in order to determine the exact thicknesses of the alternating layers. The Taguchi method is an optimization technique that uses orthogonal arrays, which brings down the number of experiments required to achieve convergence [5]. Orthogonal arrays are datasets of the variational parameters and have important properties like fractional factorial characteristics, fair distribution and orthogonality. The Taguchi method will iteratively predict the thicknesses until the response calculated using the predicted thicknesses matches the measured response. This would be helpful in getting better designs by knowing the exact thicknesses available and also for producing future batches of THz filters with higher accuracy. As the Taguchi technique is very general, its application is not limited to determining thicknesses variations. It can be used to determine other relevant parameters such as refractive index and loss of materials. It can also be used in design optimization of other THz passive components such as antennas, optics, and waveguides, and active components such as amplifiers, multipliers, and mixers.

References:

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