DESIGN OF LAYERED OPTICAL FILTERS FOR OPTICAL COMMUNICATION APPLICATIONS IN VISIBLE, INFRA-RED AND TERAHERTZ BANDS USING DIFFERENT MATERIALS AND META-MATERIALS

Mustafa Kaan KORKUT
Supervisor: Prof. Dr. Çiğdem Seçkin Gürel
Electrical and Electronics Engineering, Hacettepe University

Optical Filters

Multilayer optical filters are specialized structures that influence how light behaves when it interacts with them, affecting its reflection absorption, and transmission characteristics across various wavelengths.

As a result, it becomes possible to create optical filters that enable light to display specific behaviors at particular wavelengths. This is achieved through the careful selection of materials and arrangements.

Wavelength multiplexer systems, often referred to as WDM systems, are technologies used in fiber-optic communication. These systems combine multiple optical carrier signals into a single optical fiber by utilizing different wavelengths for each signal.

Design of Filter Structure

Layers are being noted or tagged as L and H letters indicating L for low, H for high refractive index. And create an algorithm so that it becomes suitable for number sequences. I repetitively used the same kinds of layers most of the time in different orders. And use certain different number sequences. For these two layers I picked L=1.4 H=4.5 in most cases.

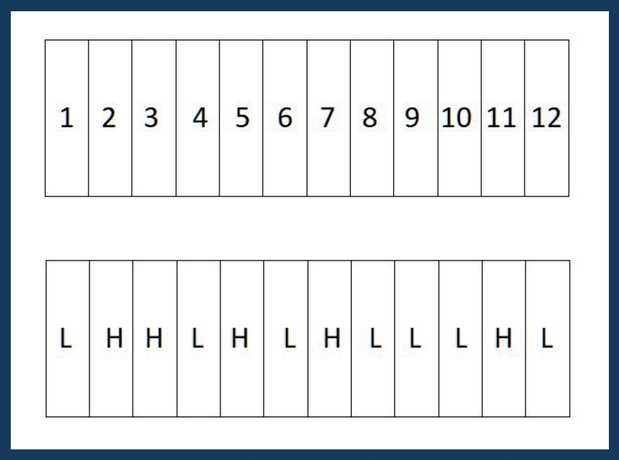

Figure 1: Implementation Example

For example if prime numbers were a sequence we would like to use we would use it as in the figure above.

Solution Methodology

The Transfer Matrix Method (TMM) is a mathematical and computational technique used to analyze the behavior of electromagnetic waves as they pass through multiple layers of different materials with varying refractive indices.

All the layers are beingrepresented or defined by a matrix by using it's parameters such as refractive index and thickness. Trigonometric functions and imaginary numbers concept also being used during the calculations.

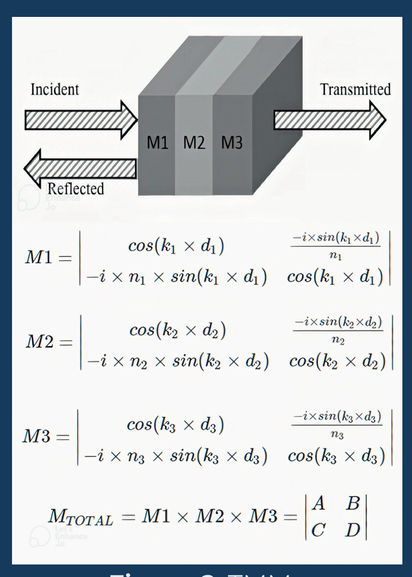

Figure 2: TMM

After all the matrices are multiplied according to their orders we evaluate the total transfer matrix and out of its elements like A, B, C and D in the figure we calculate the refletion and transmission coefficients.

Simulation Tools

A desktop application developed with Matlab was used in the reflected power ratio analysis for different repetition numbers of the designed structure.

Results and Discussion

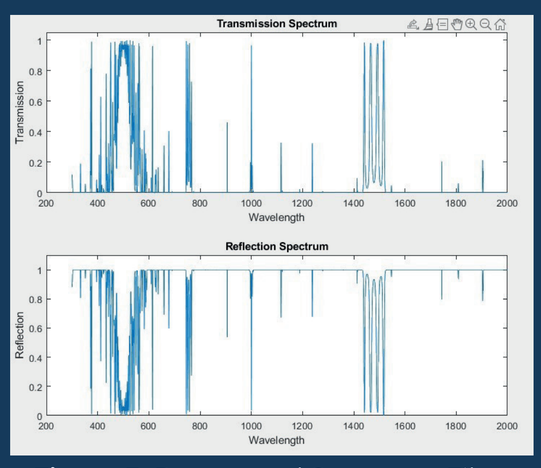

Figure 3: Pentagonal Sequence Filter

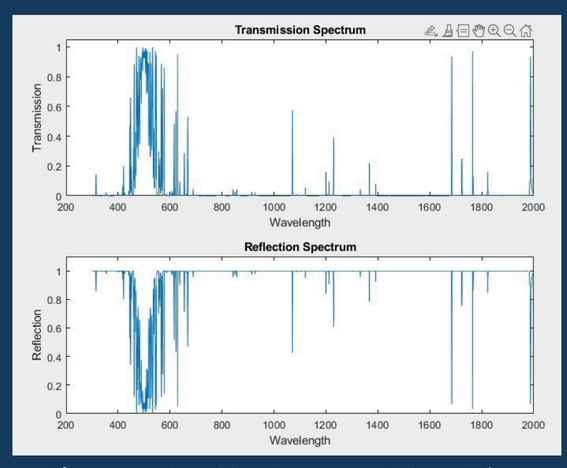

Figure 4: Sophie-German Prime Filter

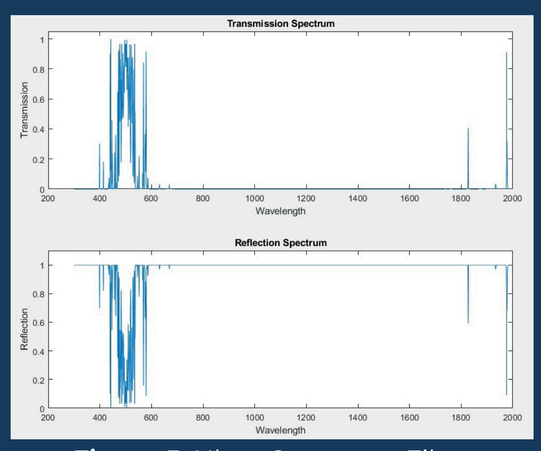

Figure 5: Ulam Sequence Filter

In the figure above of different types of filters, some of the characteristic ones are shown. They act like band-pass filters and they are strong reflectors which is quite useful in medical imaging, fiber optics, sensors and detectors.

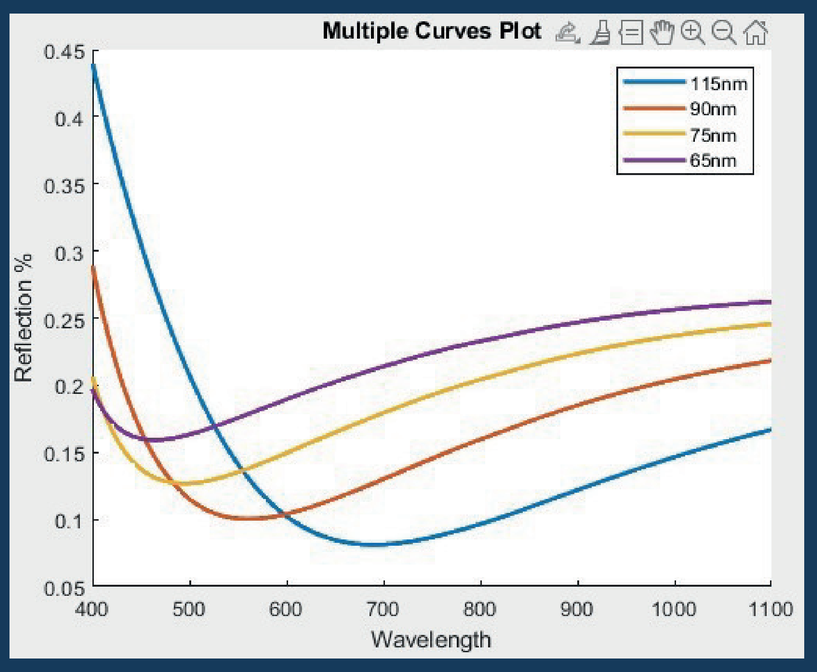

Figure 6: Solar Panel Filters

Other than coming up with different types of filters by using number sequences, there is also additional work done under this project, which is about solar panels. The efficiency of solar panels are strongly related to their filters because bare silicon material to construct solar panels reflects some of electro magnetic waves which can be considered as energy loss. In the Figure 6 SiO2 is used as a single layer filter over a silicon panel, and it's different variations of thicknesses being compared for example. In this research, the optimal refractive indexes and thicknesses calculated and got analysed.

References

‘Introduction to DWDM Technology (Technical Report)’, Cisco
Optimization and Modeling of Antireflective Layers for Silicon Solar Cells: In Search of Optimal Materials

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