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

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Introduction to Optical Filters

Optical filters operate based on the principle of selectively allowing certain wavelengths of light to pass through while blocking others.

Multilayer structures play a crucial role in various fields such as optics, photonics, and electronics. Understanding the behaviour of light or electromagnetic waves as they propagate through these structures is fundamental for designing devices like optical coatings, thin films and photonic devices.

Design of Multilayer Structure

Multilayer structures with different transmission and reflection behaviours can be adjusted by manipulating refractive coefficients of layers, thicknesses of layers, number of layers, repetition number of the structure and especially by using some special mathematical sequences.

Transfer Matrix Method

In this project, we use transfer matrix method (TMM) to calculate reflection and transmission coefficients for the entire multilayer structure. TMM allows us to break down a complex multilayer structure into individual layers and accurately models the optical response of each layer, considering factors such as thickness and refractive index.

$$M = \begin{bmatrix} m_{11} & m_{12} \\ m_{21} & m_{22} \end{bmatrix} = \begin{bmatrix} \cos\delta_j & \frac{i\sin\delta_j}{\gamma_j} \\ i\gamma_j\sin\delta_j & \cos\delta_j \end{bmatrix}$$

For the whole structure;

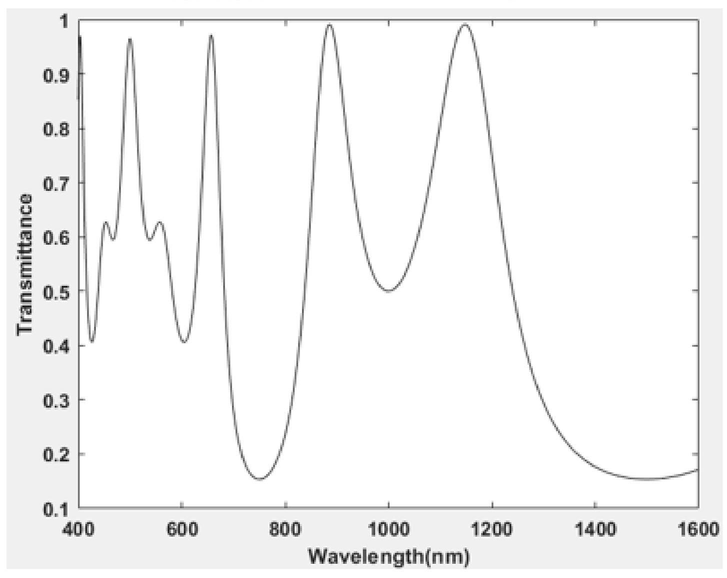
$$\begin{bmatrix} E_{01} \\ n_0 H_{01} \end{bmatrix} = M_1 M_2 \ldots M_N \begin{bmatrix} E_{N,N+1} \\ n_0 H_{N,N+1} \end{bmatrix} = M_{total} \begin{bmatrix} E_{N,N+1} \\ n_0 H_{N,N+1} \end{bmatrix}$$

$$\begin{bmatrix} E_{01} \\ n_0 H_{01} \end{bmatrix} = \begin{bmatrix} E_{i0} + E_{r0} \\ (E_{i0} - E_{r0})\gamma \end{bmatrix} = M_{tot} \begin{bmatrix} E_t \\ \gamma_t E_t \end{bmatrix} = M_{tot} \begin{bmatrix} E_{N,N+1} \\ n_0 H_{N,N+1} \end{bmatrix}$$

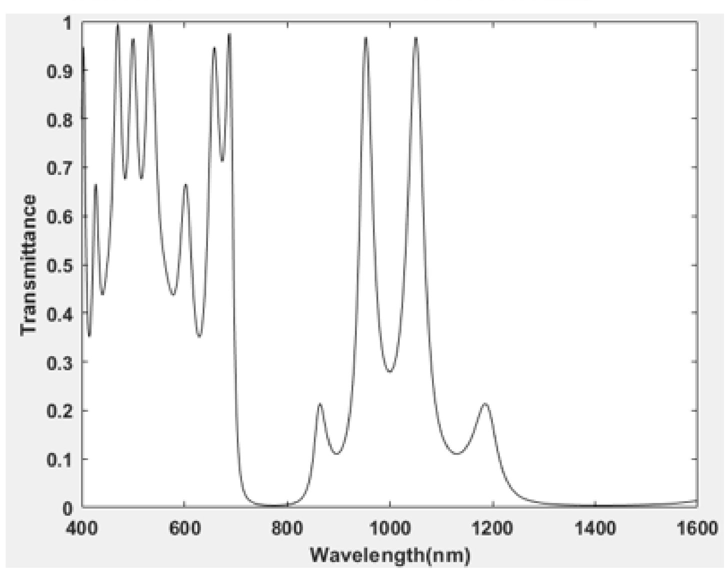
Simulation Tool

Focusing on the examination of transmittance and reflection properties of electromagnetic waves through these structures, the project utilizes MATLAB as a computational tool. The implementation involves developing MATLAB scripts to automate the calculation of transfer matrices and coefficients, creating a user-friendly interface for parameter adjustments, and visualizing the impact of variations on transmittance and reflection

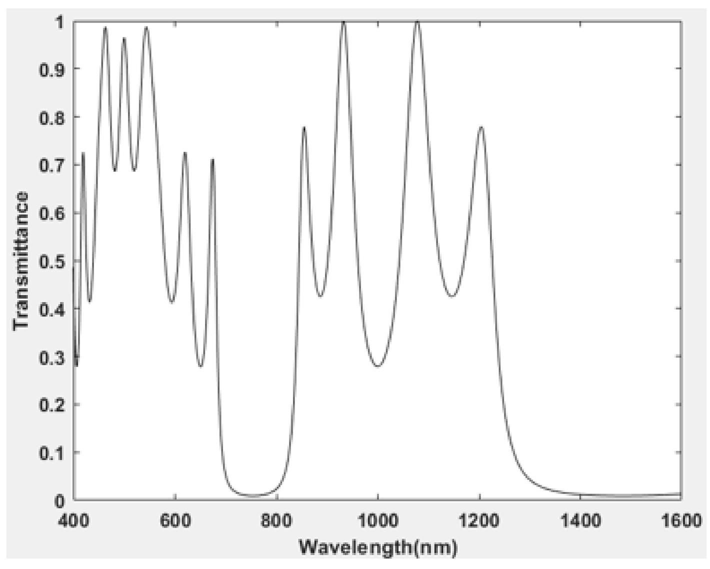
Results and Discussion



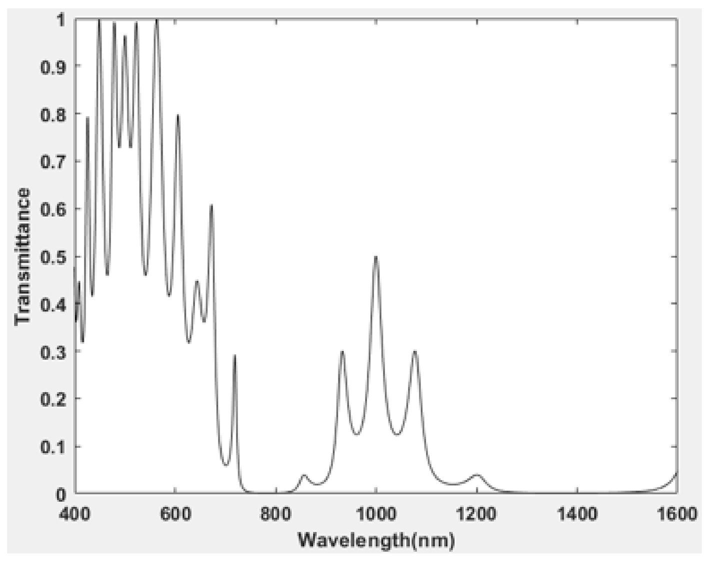
Gijswijts First 10 Element N_2=1



Gijswijts First 10 & 4th Gen. Fibonacci,N_2=1



Gijswijts First 15 Element ,N_3=1



Gijswijts First 15 & 4th Gen. Fibonacci,N_3=1

Some of the tranmission characteristic of the Gijswijts sequence and Gijswijts Sequence together with Fibonacci are given in the upper figures. The transmission characteristic of Gijswijst Sequence alone and together with Fibonacci were compared.

References

[1]Transfer-matrix formalism for the calculation of optical response in multilayer systems,Claudia Troparevski,Adrian Sabau,Andrew R.Lupini,Zhenyu Zhang

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