Available online at www.sciencedirect.com

ScienceDirect

Materials Today: Proceedings 5 (2018) 5091–5096

materialstoday: PROCEEDINGS

www.materialstoday.com/proceedings

ICMPC 2017

# Optimization of optical parameters for the design of multilayer bandpass filter using genetic algorithm

Amit L Sharma[a,b], Sunita Parinam[a,b,*], VSRS Praveen Kumar[a, b], Mukesh Kumar[a], Neelam Kumari[a], SK Mittal[a, b], Vinod Karar[b]

[a]*CSIR-Central Scientific Instruments Organization, Sector -30 C, Chandigarh,160030, India.*
[b]*Academy of Scientific & Innovative Research (AcSIR),160030, Chandigarh*

**Abstract**

This work investigates the use of genetic algorithm to design a multilayer band pass filter in visible range. The effect of choice of optical parameters such as thickness and refractive index as optimization variables on the convergence of design-solution is studied to obtain the best design that matches the desired one. Firstly, the thickness is varied; high and low refractive index combination of dielectric materials are used to design the alternate multilayer stack of 28 layers. Secondly, refractive index is varied keeping the thickness of layers constant. In both cases, the algorithm either optimizes thickness or refractive index of each layer to get the best possible solution. Initially, best matching is obtained with thickness as optimisation variable. Further, genetic parameters, population size and crossover type were varied and performance of the filter was analysed. The result of this study indicates that effect of choice of variable is dependent on the design specifications and it is not distinct. Although choosing thickness as the optimization variable showed slightly better convergence in terms of merit function when genetic parameters were not varied but this cannot be generalized as it is purely dependent on the design specification**.**


Selection and/or Peer-review under responsibility of 7th International Conference of Materials Processing and Characterization.

*Keywords:*Optical filters; Genetic algorithm;Optimization; Band pass filter

## 1.Introduction

Optical filters, which are generally used in precision applications like avionics, biomedical, telecommunications, etc. must be efficient and provide high reliability in order to get better performance of the whole system. Hence, optimal design of the filter before fabrication is very important which can be done by optimising the optical properties of the thin film.

* Corresponding author.
*E-mail address:* nancysharma2225@gmail.com

2214-7853
Selection and/or Peer-review under responsibility of 7th International Conference of Materials Processing and Characterization.

Several approaches for the design of optical multilayer filters exist which are used depending upon the type of problem [1-7]. One of the methods, called refinement methods requires a starting design which is close to the desired performance. Adjustment to the parameters of the starting design is made to improve its performance. Other method, called synthesis method does not require any starting design and they create their own design if required [8]. For some complicated problems, it is usually not possible to give a starting design and hence the refinement methods become inefficient. Genetic algorithm is one of the synthesis methods which do not require a starting design and has excellent optimisation capability to give reliable designs.

In this work, two optical parameters - refractive index and thickness are varied one by one for the design of multilayer band pass filter and their effect on the convergence of design-solution is studied to obtain the best design that matches the desired one. Genetic algorithm is used for designingof filter in visible region with central wavelength at 550 nm. 28 alternate layers of high and low refractive index dielectric materials are used for the design. The algorithm is implemented using MATLAB which takes as input the desired transmittance profile and other specifications like wavelength, refractive indices, and thickness and tries to obtain the closest possible matching profile.

## 2.Design Methodology

An optical multilayer band pass filter was designed in visible range for central wavelength of 550 nm and normalincidence.Alternate layers of high (2.05) and low (1.38) refractive index materials were used. The design was madefor 28 layers in order of HLHLHL….HLHLH with substrate refractive index as 1.52. Figure 1 shows the desiredtransmittance profile. A transmittance>99% in the 525-575 nm region was desired.

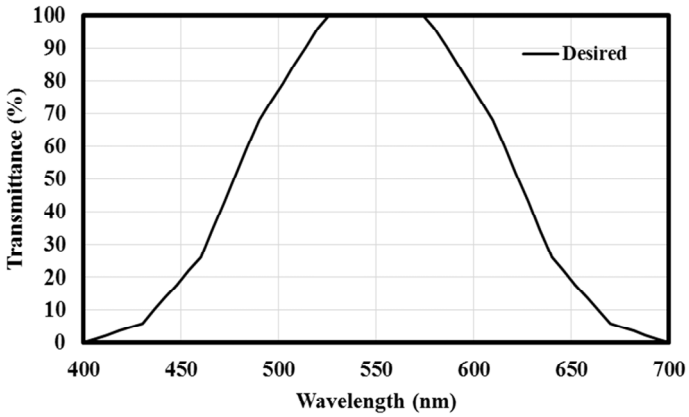


Figure 1. Desired Transmittance Profile

A computer program using Matlab$^{TM}$ environment was formulated that takes desired transmittance profile as input and tries to obtain best matching calculated transmittance profile by optimising the optical parameters like thickness and refractive index. Transmission is calculated using 2 x 2 characteristics matrix equations [9, 10].

### 2.1 Genetic optimisation

Genetic algorithm [11-13] was used for optimising the optical parameters, thickness and refractive index to obtain the best design that matches the desired transmittance performance. All the implementation was done using MATLAB.