ISSN: 0976-3104
SUPPLEMENT ISSUE

ARTICLE OPEN ACCESS

DESIGN AND SIMULATION OF NEW FRACTAL MODEL TO IMPROVE BOTH THE PERFORMANCE AND ENHANCE THE UPTAKE OF ELECTRIC OPTOELECTRONICS APPLICATIONS

Mahsa Yazdani*, Amir Reza Estakhrian Haghighi
Department of Electrical and Computer Engineering,Sepidan Branch,Islamic Azad University,Sepidan, IRAN

ABSTRACT

Efficiency increase of photovoltaic systems and the increase in produced lights from electronic devices have led to ever-increasing demand to find structures that can meet the requirements of both applications. In this regard and with the aim of designing and simulating possible structures, first in this paper, more conventional and simpler structures of Grating and Grid are addressed. Then, this issue will be studied by presenting Hilbert fractal structure. Fractal structures have desirable values in terms of light absorption and they transform all the absorbed lights into energy. The results of this research reveal that the Hilbert structure has higher and more appropriate quality compared to other structures in terms of light absorption and power generation. Thus, production of optical devices is a logical process, and, it is recommended as a widely used plan for optical device manufacturers.

Published on: 25th– Sept-2016

KEY WORDS

Plasmonics, photovoltaic systems, logical process

***Corresponding author: Email:** mahsa_yazdani2011@yahoo.com

INTRODUCTION

Prior to presenting fractal structure, its application, advantages, and etc., it should be noted that the aim of using fractals and similar networks is first to filter received wavelengths, meaning that a part of the wavelengths is absorbed and the remaining part is left (the main contribution of the current paper). In addition, another goal is light production and development of devices such as plasmonics that are beyond this paper’s scope.

A fractal is a multi-part geometrical figure, each part of which has sharp edges that can be divided into sub-parts. Each sub-parts are similar to down-scaled main structure. Obvious features of fractals are self-similarity and being independent of scale. Fractal is widely available in the nature; in fact, the idea of these networks is inspired by the nature. Most of the geometrical structures are created from fractal. For example, Sierpinski triangle, Koch snowflake, the curve of the piano, the Mandelbrot set all are fractal. In addition, most objects in real world, including clouds, mountains, turbulence, and beaches which are not simple geometrical figures also define fractal. **[Figure- 1]** depicts several fractals in mathematics. Fractal is a new branch of science, art, mathematics and recently electromagnetic physics. The majority of physical systems available in the nature or man-made systems are not originated from Euclidean geometry. Rather, structural and description features of these phenomena should be expressed by fractal geometry [1].

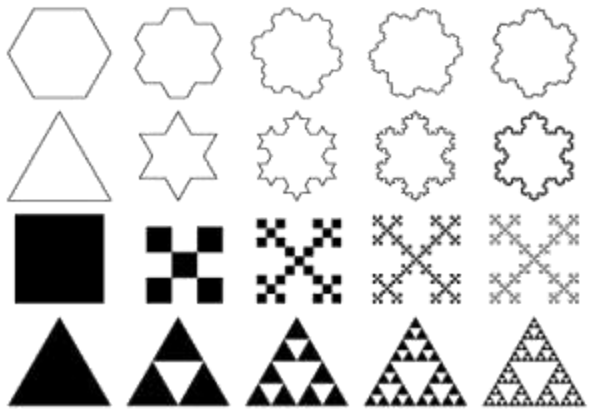


Fig: 1. A number of fractal in mathematics

Nowadays, fractal, or fractal geomety in general, is used in information theory, economics, medical science, aerospace science, hardware design, image processing and other engineering and empirical fields. One of the main features of fractal geometry is that it has irregularity characteristic in various sizes; while, Elucidean geometry has no such characteristic [2].

The most important feature of fractal and fractal geometry is fractal diemension.In Elucidean geometry, dimensions of point, line, square and cube are 0, 1, 2, and 3, respectively. Overall, dimension of a set is described as the space it occupies. However, in fractal geometry, there exist various dimensions such as topological dimension, similarity dimension, Hausdorff dimension, and box-counting dimension [2].

Transparent electrodes based on lead oxides such as indium tin oxide or zinc oxide play an important role in devices such as lasers, solar cells, light emitting diodes (LEDs) and displays and increase the efficiency of various kinds of optical devices. However, their performance is far from ideal state because they are costly, fragile and unsuitable for use with certain organic materials. Various steps involved in the development of transparent electrodes can be seen in **[Figure- 2]**.

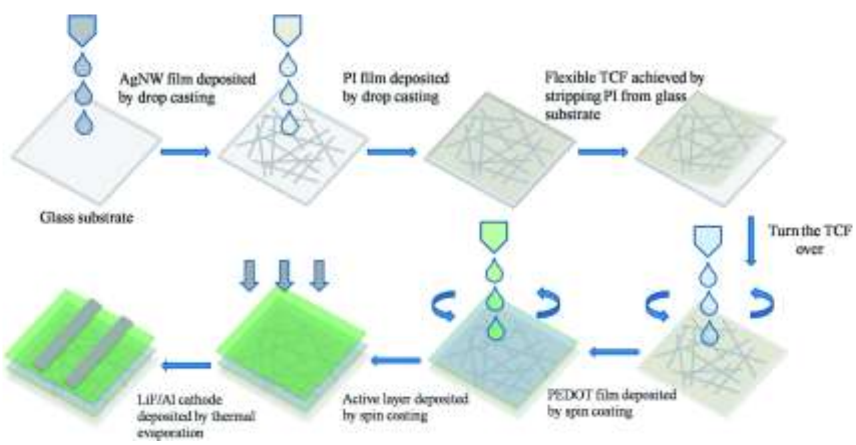


Fig:2. Various steps involved in developing transparent electrodes

The use of fractals with narrow layers is one of the in-progress options to find appropriate alternatves with conducting materials in photonic field. The merit of these structures is higher robustness and proper electric current conductivity [3-4].

Fractal aplications

Fractals which are considered as a novel branch in electromagnetic science have various applications in optical fields. These applications that are fundamantal sub-sets of optoelectric are divided into three sub-branches that will be addressed in the next sections.

1. Light wavelength filtering

Since fractals have the ability to absorb light in different wavelenghts and are adjustable, they can be used to separate wavelengths in the ultraviolet, visible and infrared regions. This has widespread applications, some of them will be described. Before presenting these applications, it should be noted that these cases by the existing techniques are difficult and are considered among great advantages of fractal structures.

In solar panels in order to separate infrared wavelengths, absorb them, and pass the remaining wavelengths to avoid of heating in solar panels for panels' efficiency increase.
- Production of cold light projectors in hospital operating rooms.
- Manufacturing of UV lamps in applications such as lithograph film print with higher quality.
- Creating ultraviolet lamps to print laminates on the PC board and IC devices fabrication.

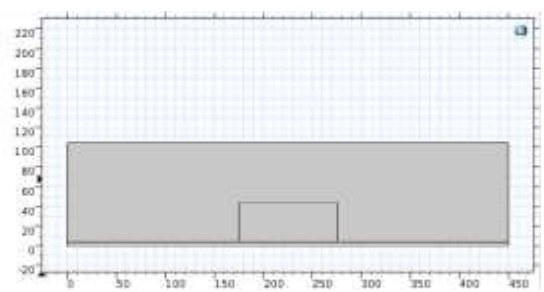
2. Laser

Optic and laser knowledge have seen huge advances in recent decades. Considering the brilliant future and its ever-increasing applications, it is required to train expert staff familiar with theoretical bases and practical fundamentals. [6]

3. Optical detectors:

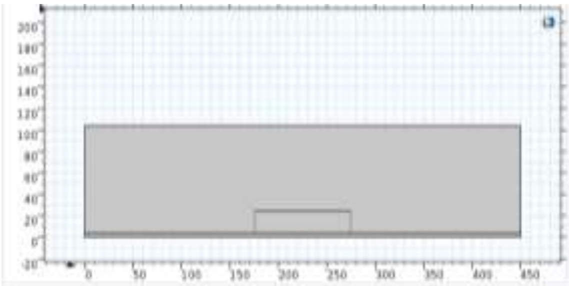
Optical detectors are important part of optical integrated circuits (ICs). Metal-semconductor-metal optical detectors are one type of optical detectors. Characteristics of these detectors has been improved with the advancement in plasmonic science [3, 5].

Simulated structures

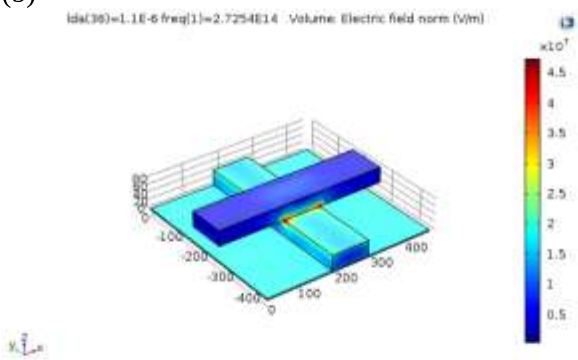


(a)

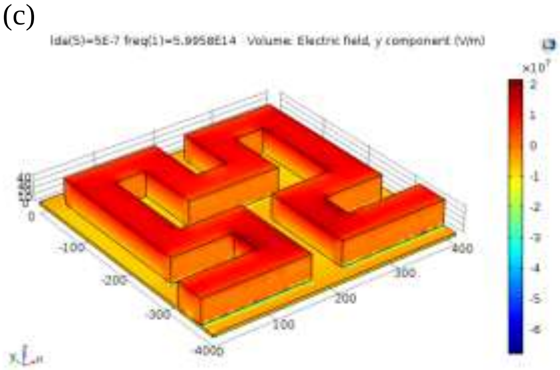
ISSN: 0976-3104



(b)



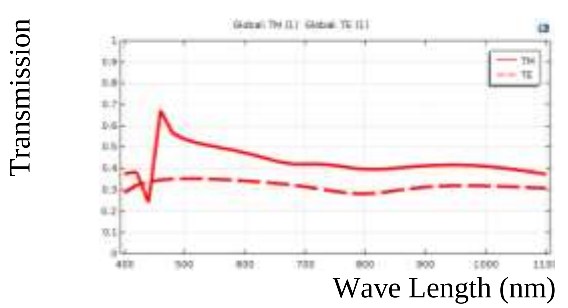
(c)



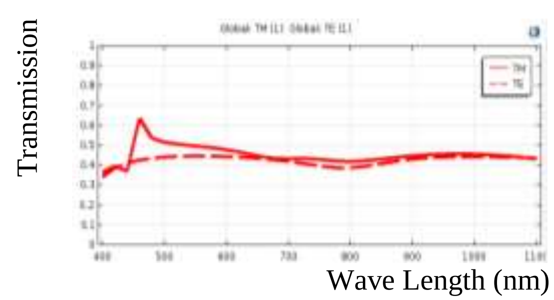
(d)

Fig: 3. simulated structures (a) Grating structure (side view) (b) Aluminum depth decrease (c) Grid structure (d) fractal structure

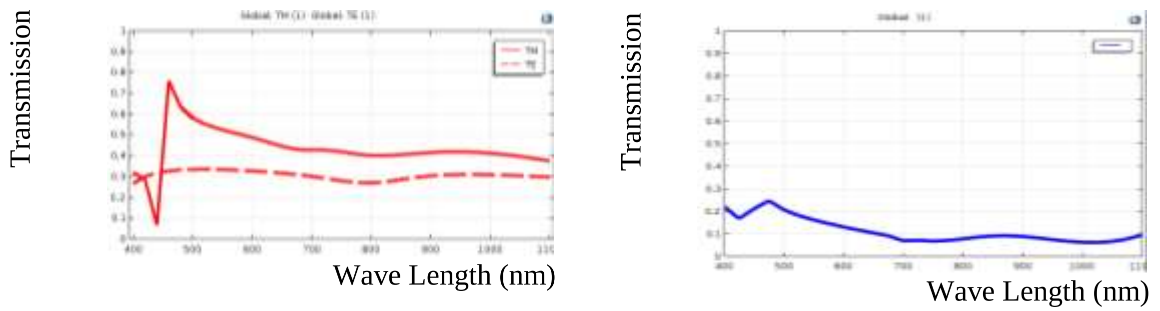
………



(a)



(b)



(c) (d)

Fig: 4. Obtained outputs (a) Grating structure (side view) (b) Aluminum depth decrease (c) Grid structure (d) fractal structure

……

CONCLUSION

Designed transparent electrodes in fractal structure have the ability of connection and adjustment with various devices. This feature has led to widespread use of this design. This structure has two probes in large scales that can be connected to the other devices. Design and simulation of transparent electrodes based on fractal structures, and based on Grid and fractal structure for 2-D and 3-D optoelectric applications which are among the most used techniques in optoelectric field revealed that more uniform passing through TM and TE angles in fractal structure have more appropriate performance. Designed electrodes in fractal structure of this paper with the development of proper wavelength window can have light passing in simultaneous manner with electric current and eliminate existing obstacles against light exchange of optoelectronic device. Based on the results of the current research, one can show superior performance of fractal geometris compared to grid and network with similar geometrical parameters through integration of silicon optical detectors and photon measurements. Indeed, nano-structure metal film with fractal gap is proposed as novel transparent geometries with high bandwidth and polar independent transform and has high performance. By investigating the transfer and other relationships, it can be concluded that there is a direct relationship between transfer and coverage close to penetration threshold or close to infrared band region.Since metals as a substrate metal film has higher absorption even in minimum passing of fractals and their passage quantity does not change in high wavelengths, it can be asserted that fractal regular patterns created on metal films in this paper are able to use these structures as a transparent electrode.

Chromatcic curves of passing value of sub-structures composing main structure which is addressed as a novel issue in this paper maniests that fractals can have more uniform passing compared to other structures. It has significantly higher performance stability than simple structures of Grating and Grid. This is cpmpatible with the results of previous studies.In the analysis of the simulation of one part of a fractal with the overall structure giving similar results, it can be mentioned that there is no need to depict overall structure for investigation and simulation of novel structures and only the illustration of structure main part is adequate for understanding performance procedure of the overall structure. In addition, higher analysis and simulation times are obviated.

As a novel and un-investigated issue, in this paper, structure depth parameters and air layer depth are studied. The results obtained reveal that in both states, depth decrease leads to performance stability in various wavelengths. That is, regarding both air layer depth decrease and fractal layers decrease, minimum and maximum passing in various wavelengths approach to the mean passing of different wavelenghts. Thus, it can be asserted that these two layers have direct performance.If electrode structure of simulation parameters assumed to be independent, their impact on optical permeability is depend on shape and kind of electrode structure.

CONFLICT OF INTEREST

Authors declare no conflict of interest

ACKNOWLEDGEMENTS

None

FINANCIAL DISCLOSURE

None

REFERENCES

[1] Patrzalak E. [2000]Fractal Properties‹" *Stan Ackermans Institute IPO*

[2] Drachev VP, Bragg WD, Podolsky V A. [2016] Large Local optical activity in fractal aggregates of nanoparticless‹" *Department Of Physics New mexico State University Las Crucess, New Mexico* ‹ pp. 18-20 ‹2016.

[3] F Afshinmanesh ‹AG Curto, KM. Milaninia ,NF VanHulst و, Brongersma ML. [2014]Transparent Metallic Fractal Electrods For Semiconductor Devices‹" *Nano Letters* ‹pp. 305-345

[4] Lovejoy S, Schertzer D. Gagnon JS. [2005]Multifractal Simulations of the earths Surface and Interior: Anisotropic Singularities and Morphology‹" *Physics Department McGill University montreal Canada* ‹pp. 37-54.

[5] Sandru A. [2012] "Fractal Structuers for Optical Applications Feasible with 2D Nanotechnology‹" *Modern Optics* ‹pp. 199-204 ‹

[6] Shek [2015] CH .Fractal structure and optical properties of semicontinuous silver films, *Elsevier* ‹pp. 300-315‹