Hybrid C36 Fullerene and Silicon Optical Interconnect

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Abstract-*Fullerene is one of the 0D (zero dimensions) materials of carbon's new family. Fullerene has some great electrical and optical property to overcome current optical silica waveguide in terms of dimensions, optical parameter and technique. In this paper we are presenting hybrid model of fullerne and silica material for optical interconnect medium.*

Keywords-C36 fullerene, optical communication wavelength, bonding, anti-bonding, fullerene

I. INTRODUCTION

To match the foot with latest optical technology like low power requirement, less dimensions, tera-hertz modulator we need to fabricate optical waveguide with a new material which should have fast response, low absorption and less scattering losses. The new carbon family is the best option for latest requirement. This new carbon family is available in 0D (fullerene). To overcome absorption problems, energy savings criteria, scale reduction in optical interconnect and high strength fullerene is one of the best material.

Fullerene is actually a zero dimension hexagonal structure of carbon atom in which each carbon atom is co-valet bonded to another three carbon atom, because of this each carbon atom have one free or dirac electron to make electrical or optical conduction so fast. This is the key property of fullerene which is in contrast for optical communication. [1]

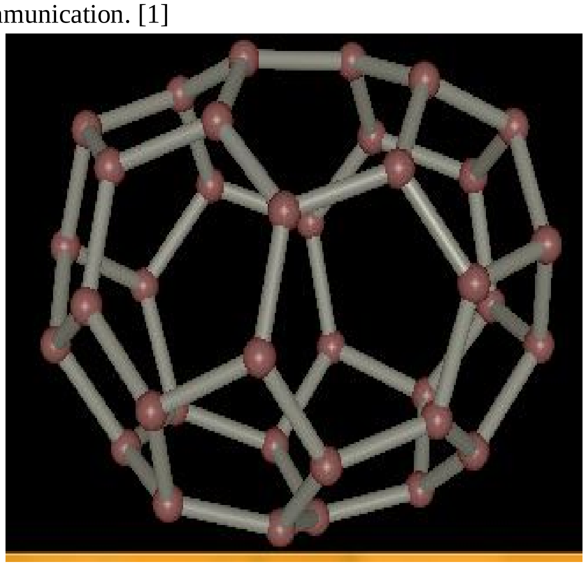

Fig.1. C36 fullerene by NINITHI software.

II. C36 FULLERENE BASED OPTICAL SIMULATION

C36 fullerene based optical waveguide with high optical mode with constant velocity parameter 108cm/s2. We are designing and analysis at different diameter of C36 fullerene and taking out optical mode analysis graphical analysis of that and getting final conclusion from previous analysis at different diameter.[3]

III. SIMULATION AND MODE ANALYSIS

We are simulating C36 fullerene based optical waveguide on COMSOL multi-physics in 2D mode with EWFD (electromagnetic wave, Frequency domain) physics with following equation:

$$\nabla \times \mu_r^{-1}(\nabla \times \mathbf{E}) - k_0^2\left(\epsilon_r - \frac{j\sigma}{\omega\epsilon_0}\right)\mathbf{E} = \mathbf{0}$$
$$\lambda = -j\beta - \delta_z$$
$$\mathbf{E}(x,y,z) = \tilde{\mathbf{E}}(x,y)e^{-ik_z z}$$

…….eq.1

We are simulating optical mode analysis with carrier wavelength of 1550 nm at different diameter of 100nm.

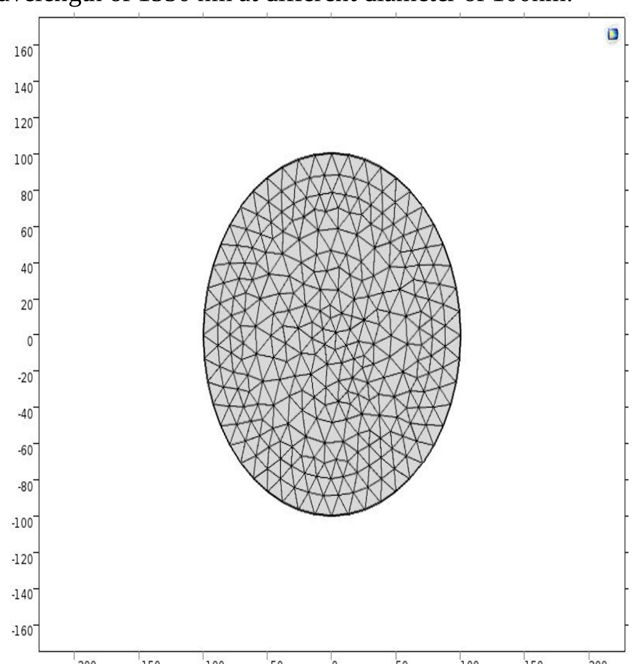

Fig.2. mash analysis of C36 fullerene by COMSOL Multiphysics.

IV. ANALYSIS

In this analysis we are designing at diameter of 100nm with material C36 fullerene. Actually to fabricate optical waveguide without clad having maximum errors and high attenuation. It is also a tough task to fabricate practically a single fullerene wire. To protect fullerene from outer atmosphere and refractive index a clad of silica is added with 150 nm having a great difference between both. As shown in upcoming figures.

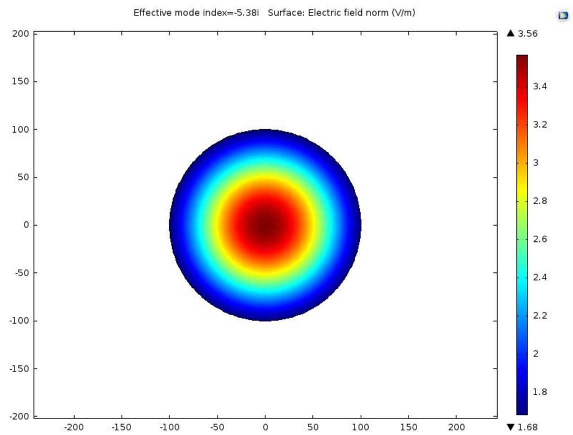

Fig.3: Mode analysis of 100nm fullerene with full communication wavelength.

Finally we get mode analysis with effective mode index of -5.38i at 100nm. Finally we are getting less effective mode index when increasing radius of 2D circle. We also have different error probability plot with more smooth point shown in fig.14.

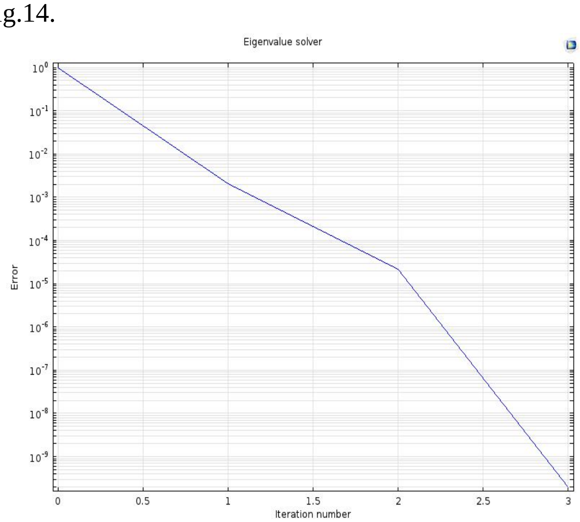

Fig.4: error probability graph at 100nm fullerene with full communication wavelength.

The main drawback of this project is that it showing only property but practically we cannot use it in optical interconnect because of absence of clad.

As we discussed previously that without an outer clad a optical wire have high attenuation. To overcome this problem we are demonstrating a hybrid combination of silica and C36 fullerene with main core of fullerene and clad of silica. Refractive index of fullerene is much higher than silica material, because of this reason maximum light information would be travel from fullerene core and clad will work as protector.

V. RESULT

In this simulation we can see that this property of hybrid optical interconnect of fullerene and silica can overcome drawbacks of current optical interconnect technology i.e. SOI (silicon on insulator) in terms of dimensions and as well as in speed. It has also great property than fibres that are it has only 2.5% absorption of signal light hence we can transmit signal light with less attenuation and with a great high speed for optical interconnect on chip. We also can use this material as a high-speed optical sensor at tera-hertz range.

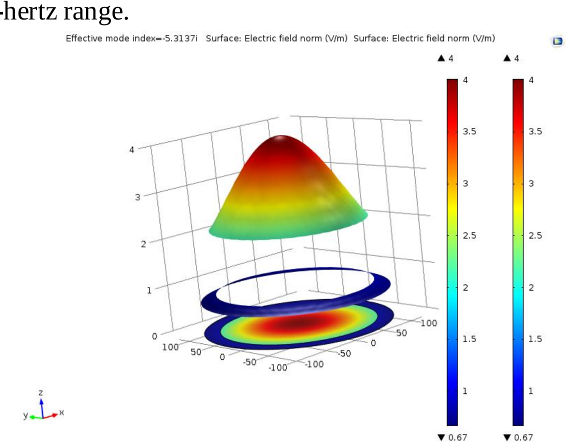

Fig.5: Mode analysis of 100nm fullerene core and silica clad with full communication wavelength.

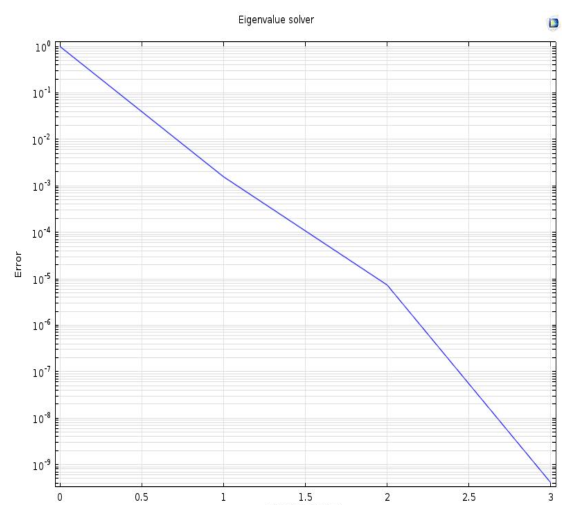

Fig.6: Convergence plot of 100nm fullerene core and silica clad with full communication wavelength.

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