Electric Field Distribution of ZnO-PCL Nanocomposites Using Rectangular Waveguide, Microstrip and Finite Element Method

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Introduction: It is vital to accurately and efficiently use a computational method that will be able to model electric field of substrate materials on transmission lines structure. Also, to understand the behavior of materials when used in microwave devices, the field properties of the substrates needs to be investigated. The computational values of the scattering parameters and electric field distribution can also assist engineers and designers to optimize microwave circuitry in electronic devices. No attempt has been made by researchers to investigate the distribution of electric field when placed inside a rectangular waveguide and microstrip lines.

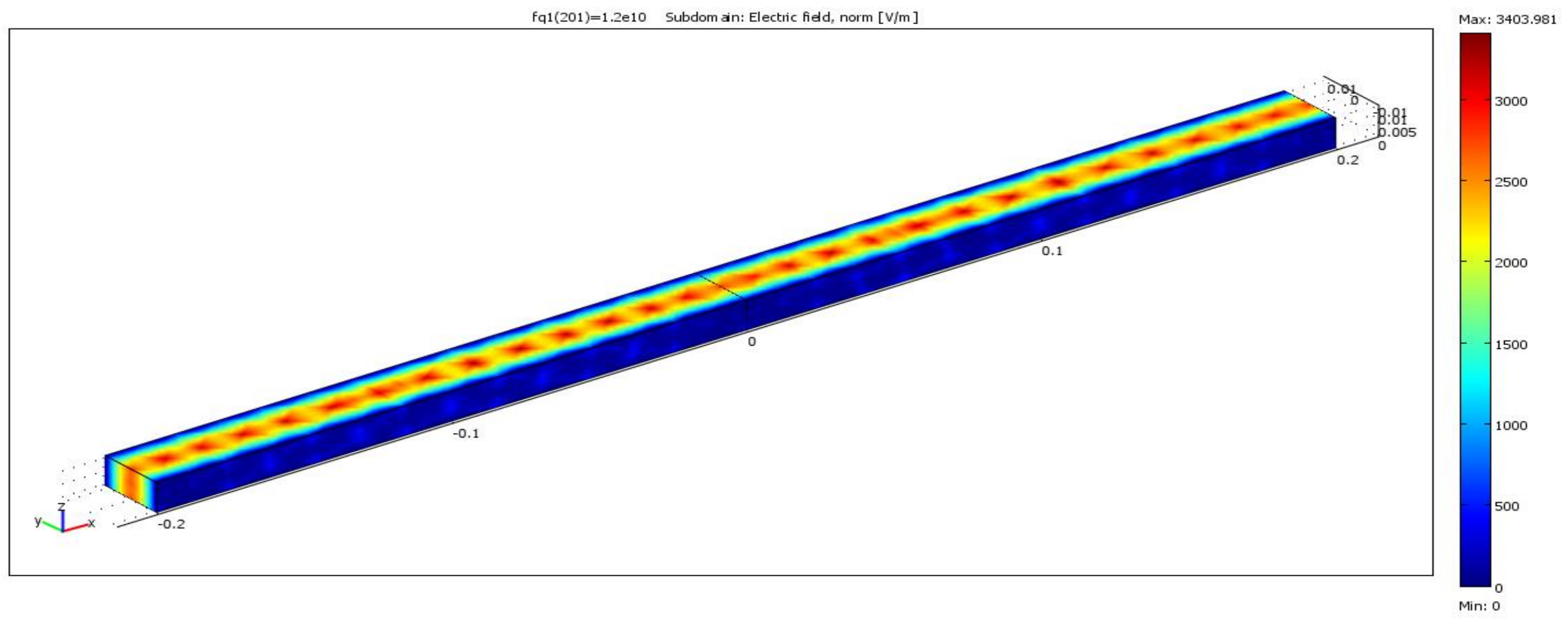

Figure 1. Simulated empty waveguide

Computational Methods: The FEM simulation technique used to calculate the full three-dimensional electromagnetic field inside a structure is based on the finite element method. The analysis in FEM involves four important steps [1]. These steps includes; (a) discretizing the solution region into finite number of elements (b) deriving governing equations for a typical element (c) assembling of all elements in the solution region and (d) solving the system of equations obtained. In discretizing a solution region into number of finite elements, a region is divided into four non-overlapping elements having seven nodes. The approximate potential (Ve) within an element for the whole region is given as [2, 3]

- $\propto_1 = \frac{1}{2A}[(x_2y_3 - x_3y_2) + (y_2 - y_3)x + (x_3 - x_2)y]$
- $\propto_2 = \frac{1}{2A}[(x_3y_1 - x_1y_3) + (y_3 - y_1)x + (x_1 - x_3)y]$

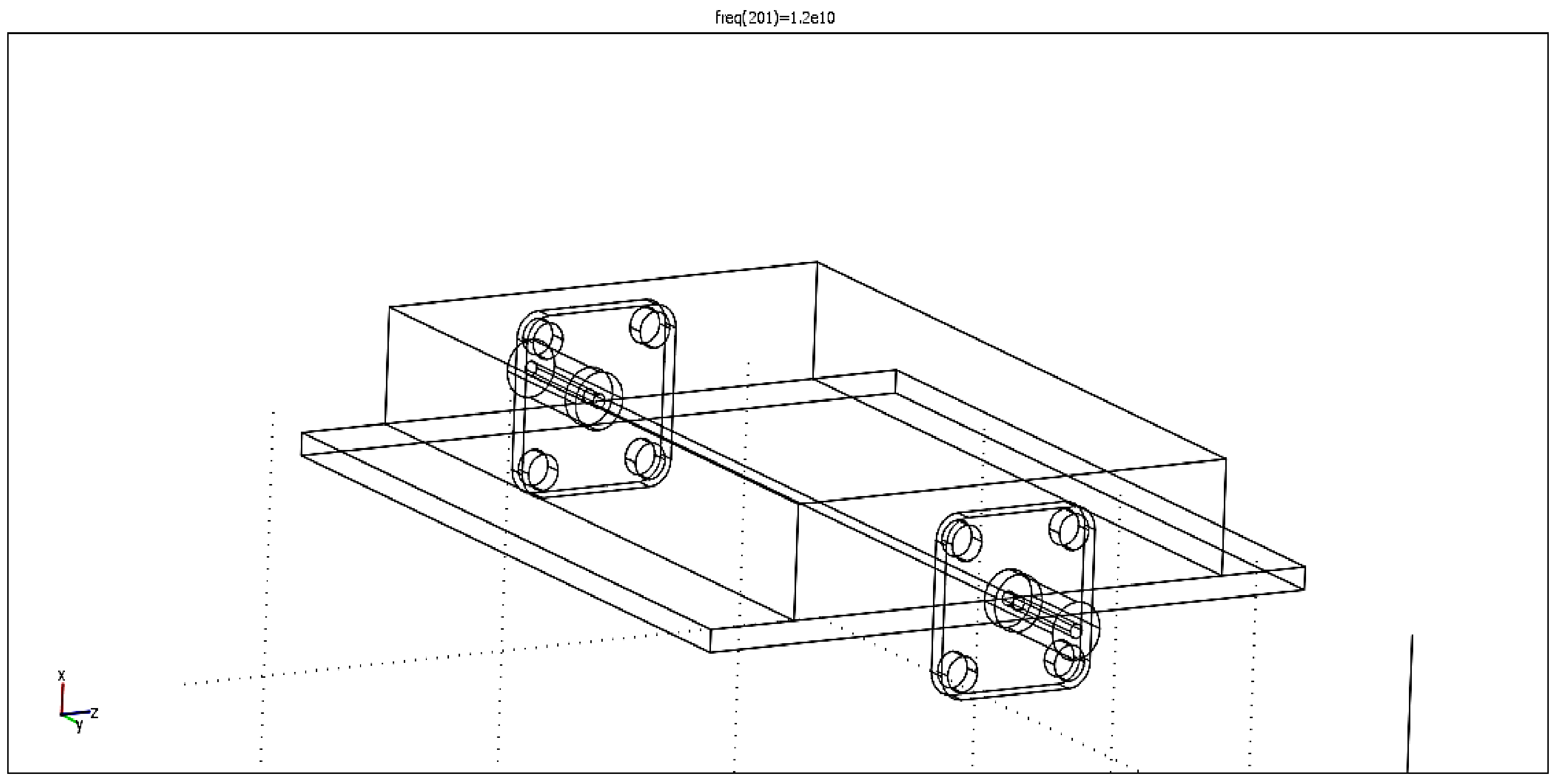

Figure 2. Simulated Microstrip with ZnO-PCL composites substrates

Results: The simulated scattering parameter of the ZnO-PCL composites were found to be in good agreement with the computational electric field of the composites using microstrip techniques (See Fig. 3 and 4).

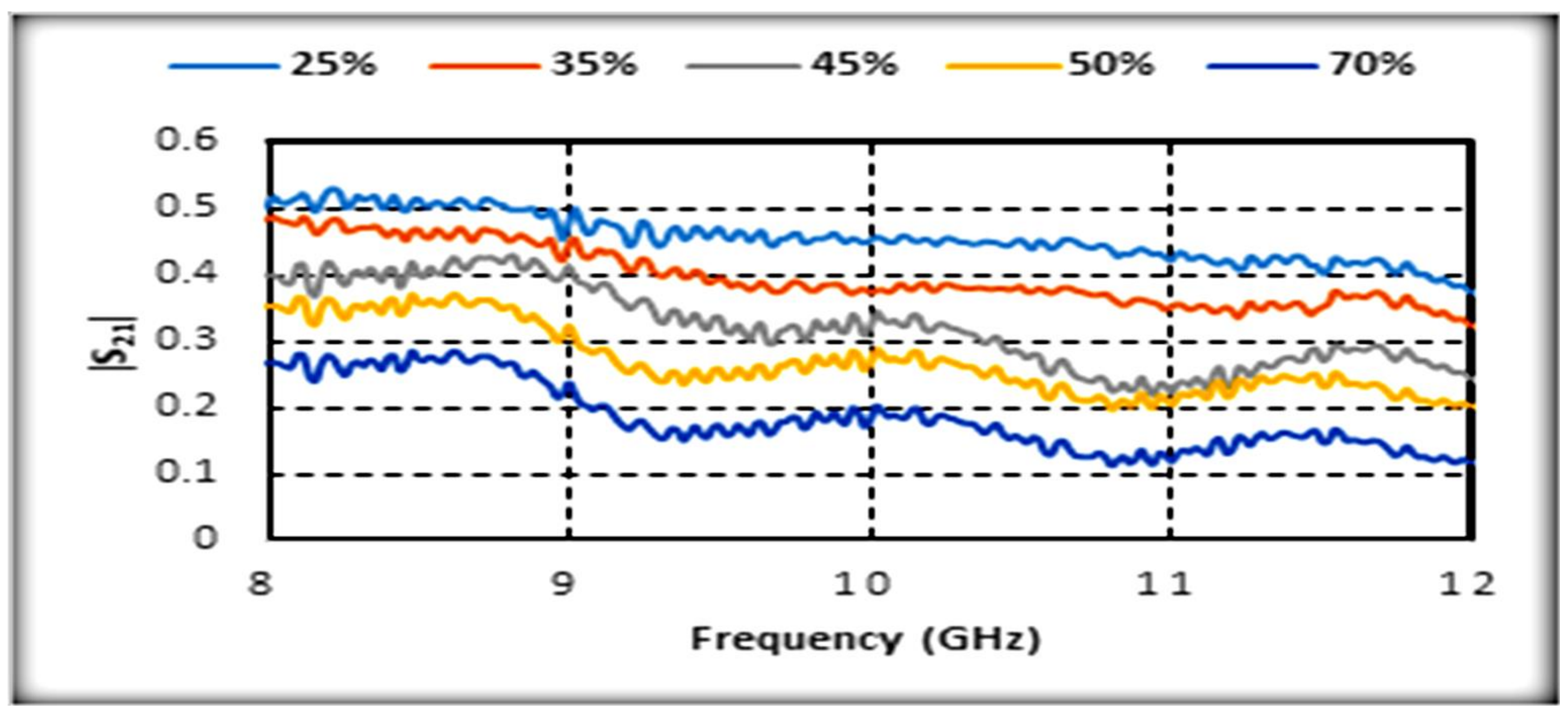

Figure 3. Variation in S_{21} for loaded microstrip antenna

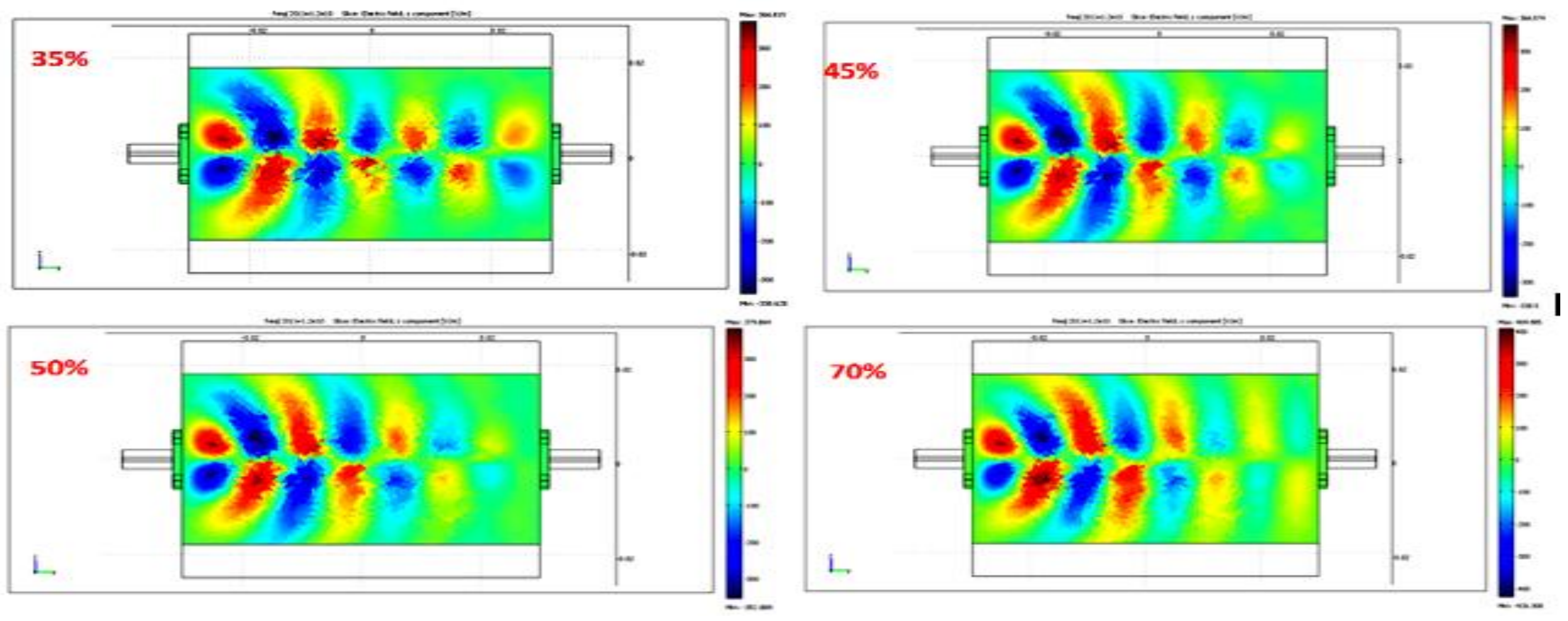

Figure 4. Electric field of various % ZnO-PCL composites

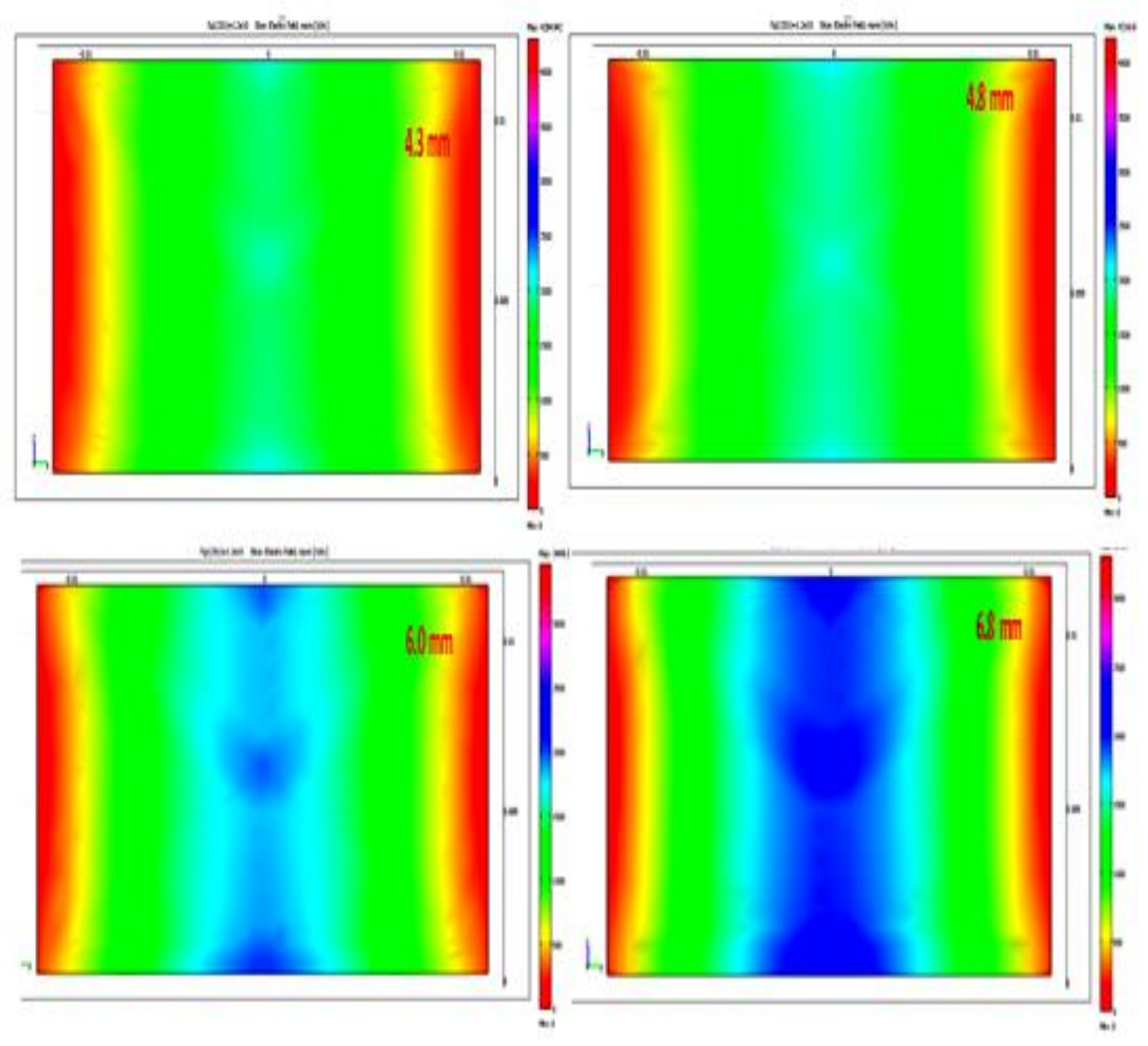

Figure 5. Electric Field distribution at output surface of sample inside a RWG

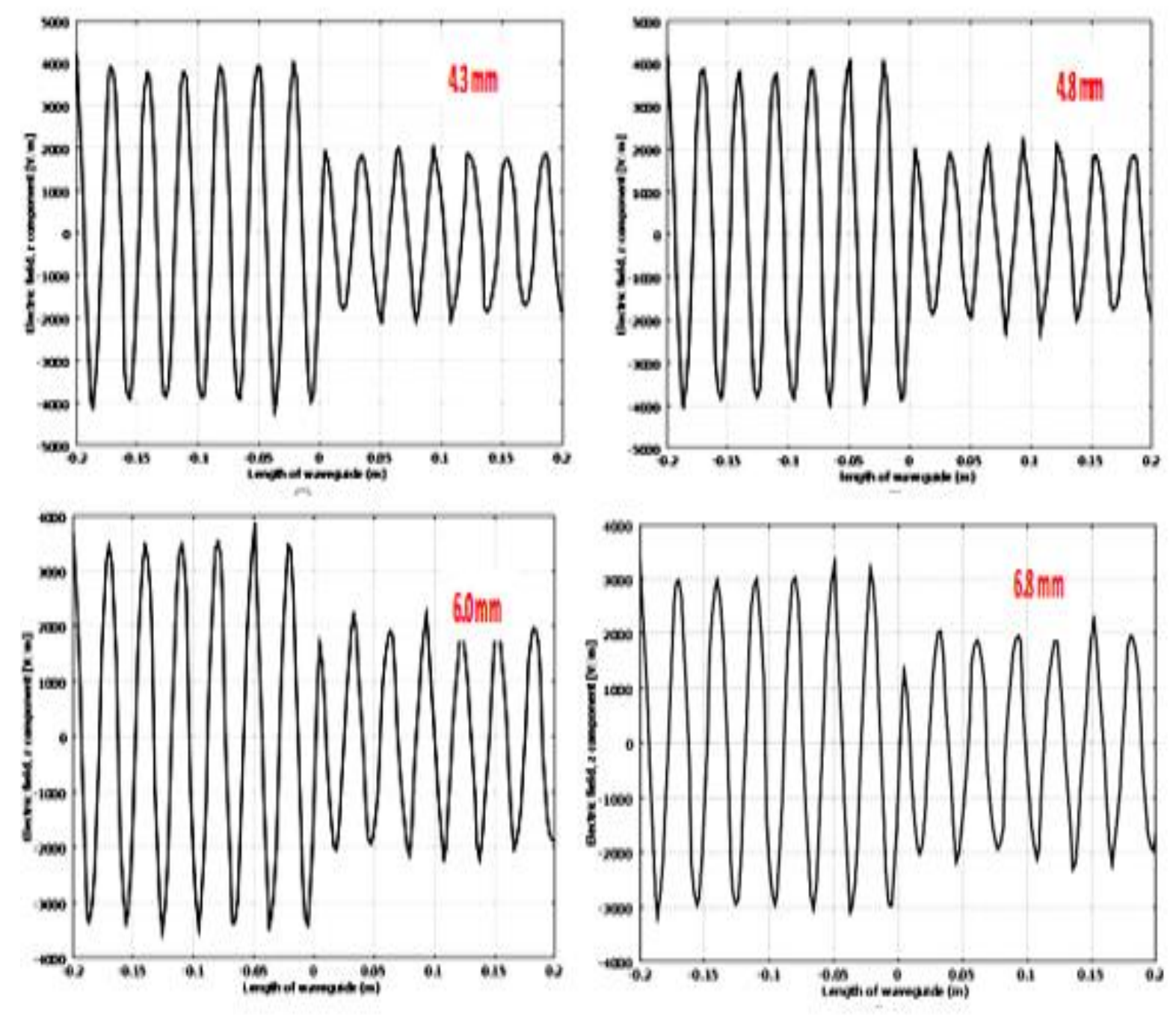

Figure 6. Electric Field intensity for the different ZnO-PCL composites

Conclusions: The results showed, distinctive behavior of electric field for each sample dimension and the simulated scattering parameter of the ZnO-PCL composites were found to be in good agreement with the computational electric field of the composites using microstrip techniques. The electric field radiation pattern distributed through the samples is dependent on the amount of nano filler content in the composites. Finally, microstrip can be extended to cover the measurement of permittivity of materials.

References:

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