Optical Supertrap with Complete Photonic Lens

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ABSTRACT:
In this paper, using the perfect lens has created electromagnetic trap. Negative refractive index and superlenz that are two important Electromagnetic phenomenon’s are were combined to create this trap. A two-dimensional photonic crystal structure consists of a rectangular dielectric rods were used in the array. High resolution and short focal length lens makes a beam of highly concentrated and highly convergent that have the requirements for electromagnetic traps. This trap can be changed without moving the lens in the microwave frequencies.

KEYWORDS: photonic crystal, electromagnetic trap, superlens, negative refractive index.

1. INTRODUCTION

One of the most important phenomena in optics is refraction at the boundary of two environments that is an expression of this phenomenon using Snell's law. With this law, how the light passes from one medium to the next determined with refractive index [1].

This relationship gives expression refraction in natural environments. In the natural environment, the refractive index is always positive. Veselago in 1967 revealed the presence of substances that didn’t follow Snell's law. This material had a negative refractive index [2 and 8]. Because these materials are not available in nature, called metamaterials [3, 4]. In 2000, Pendry and Smith demonstrated experimentally that there was the possibility makes materials with electro-magnetic properties. These materials can have a negative refractive index, in other words the possibility of making of metamaterials were a simulation [8-14].

Metamaterials are periodic structures with different arrangement. The first type metamaterials consists of a combination of wire and rinds made in the laboratory that was in a square arrangement and a repeat of the unit cell periodic structure was created. In these arrangement right wires was antenna that acts a function of electric field and rings was antenna that acts a function of a magnetic field [3].

Also, Photonic crystals are periodic structures. Any cosmetic that its optical properties such as refractive index and electrical permeability coefficient in one direction is changed periodically and in other respects remain constant, called the photonic crystal. Repeat one-dimensional makes one-dimensional photonic crystal and repeating in two dimensions and three dimensions creates respectively, two-dimensional and three-dimensional photonic crystal. There is a band gap in the structures, which causing electromagnetic waves cannot spread in certain frequencies [15]. Since these structures in a specific frequency range act like metamaterials, have special significance.

The Photonic crystals with Properties of negative refractive index have been used in the creation of sensors [3], antennas [5], mirrors [6], superlens [7, 14], etc. [3]. Full lens created using of the photonic crystal have capabilities of sub-wavelength imaging in the microwave frequencies.

In this paper, an application of photonic crystal is used as a flat lens with negative refractive index that addition to imagery with high resolution, creating an electromagnetic trap [16]. This technique was providing possibility of manipulation of neutral dielectric particles with a simple gesture of microwave source.

2. SUPERLENZ

Structure of photonic crystal, a structure designed in [7]. This structure is a two-dimensional photonic crystal of silicon bars arranged in a triangular arrangement. The structure is located in x-z and dimensions of each rod in the x-direction and in the z direction is equal. a is horizontal distance between the centers of two bars, which is called the constant network. The unit cell of this structure shown in Figure 1.

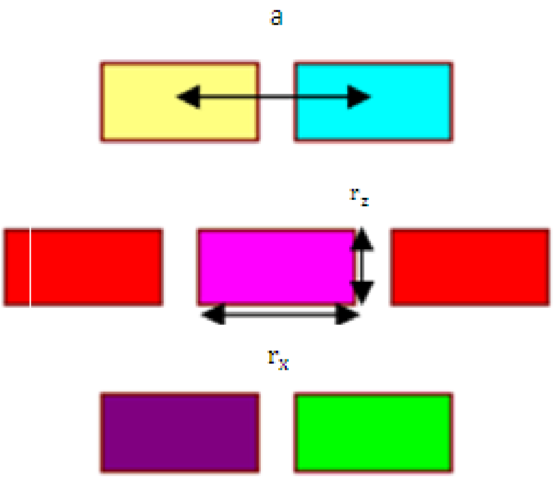


Fig. 1. A unit cell of the photonic crystal.

The two-dimensional array of photonic crystals created a superlens. Finite difference time domain simulation is used to simulate there where. The results show in Figure 2.

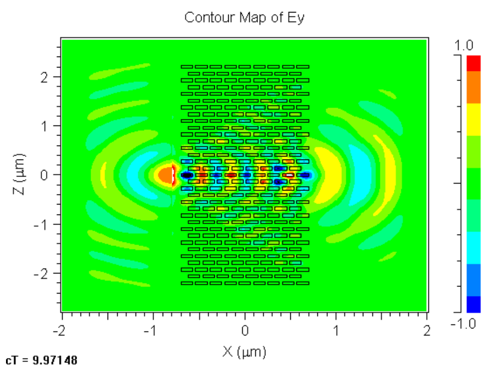
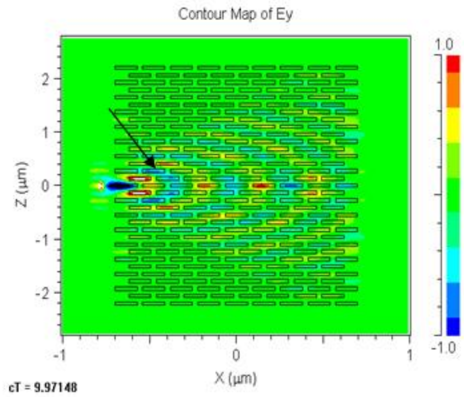


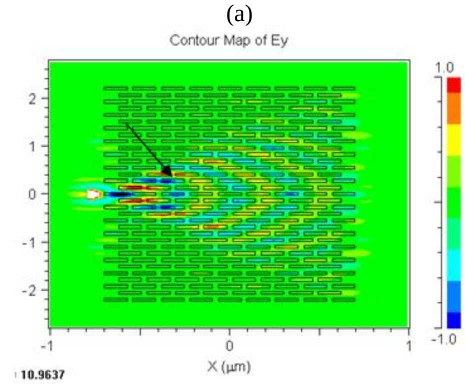
Fig. 2. Behavior of photonic crystal superlens with simulation finite difference time domain.

This structure has the properties of a superlens. In this structure, the light source placed on the left side, its distance from the structure is less than the constant network. Once the light published in slab photonic, then to penetrate inside the structure and gives the right of the image.

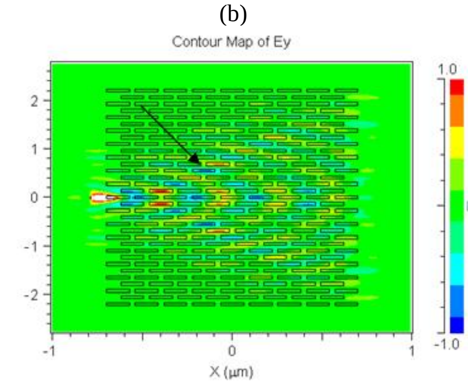
3. THE ELECTROMAGNETIC TRAP



(a)



(b)



(c)

Fig. 3. (a) electromagnetic trap, (b) particles moving along the horizontal axis (c) the movement of particles along the horizontal and vertical axes.

Figure 3(a) shows primary cluster in the bar where after the light moves in Figure 3(b) to a new position where its cluster renovated is garlic. In this process, the particles are pulled along the horizontal axis.
This trend has continued in the fig 3(C) and particles shifted to a new position. Note that cluster size is changed in over long distances of move. In this process, Microwave electromagnetic dragging of neutral particles along in both of the vertical axis and along the horizontal axis. This is expected—because the flat lens has translation symmetry for imaging and

is devoid of a unique optical axis. Therefore, there is no field curvature and the quality of the monopole image is independent. This is a very beneficial property for trapping as it also allows for effective manipulation without lens movement. In addition, the flat lens provides a novel mechanism for using gradient forces not only as traps but also as arrays of manipulations and in fluidic systems particles can be manipulated by arrays of sources turned on and off sequentially to affect their movement.

4. CONCLUSION

In this paper, we experimentally demonstrated microwave electromagnetic trapping and manipulation of neutral particles using a negative-refraction flat lens. The advantages of the flat lens, including super-resolution and the absence of field-curvature, play an essential role in improving the overall performance of such electromagnetic tweezers. Although this experiment was carried out in the microwave regime, the technique neither is suitable for optical wavelengths, sources nor on the lens is required to manipulate the particles. We will report this in the future.

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