EM Wave in an Anisotropic medium

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Abstract

The waveform characteristics when the wave is made to propagate in an anisotropic medium is explore here. The axes arec hosen to be the principal axes, so that only the diagonal components are nonzero, and anisotropy in permittivity is only considered.

1 Introduction

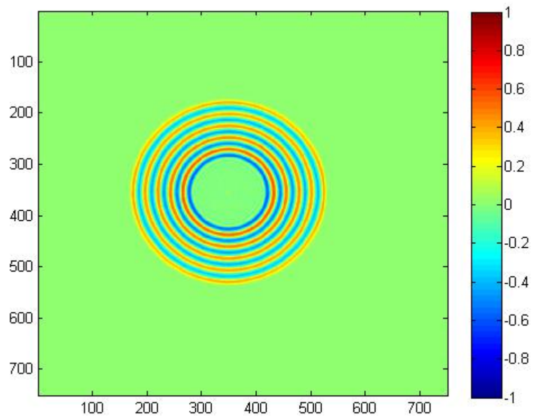
The update equations for constant epsilonx, epsilony and epsilonz have been constructed and invoked in both TE and TM case. A Yee cell has been chosen here, with the topleft corner containing 0 electric field, and bottom right corner portion having 0 magnetic field. The input is taken from two png file, one containing RGB information about the succeptibility in x,y and z tensor components and the orther containing the position of the source.

The simulation domain is 10 micrometer. 750 pixels have been used left to right and hence the grid spacing has been chosen to be 10micrometer/750 = 13 nanometer. The Amplitude of the sinusoidal source is chosen to be 1 unit, in both TE and TM case.

The epsilon matrix has been chosen such that epsilon x = 8, epsilony = epsilonz = 1.

2 Point source case

For the case of a point source placed at the center, for TM polatization, one can see that the equations do not get modified at all, as all equations with the epsilonx term becomes zero. Only dependance is there for epsilonz, which is chosen to be 1 anyway. Hence it can be expected that there is absolutely no difference between this case and the case with a point source in free space. The response obtained is as shown below:



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For the TE case, the epsilonx conponent gets added in to the equation. the speed in the x direction should be expected to be 1/sqrt(2) times c. Hence with time, the output will resemble an oval, with it's major axis along the y axis and minot axis along x direction. the ratio of these lengths is sqrt(8). The response is as shown below:

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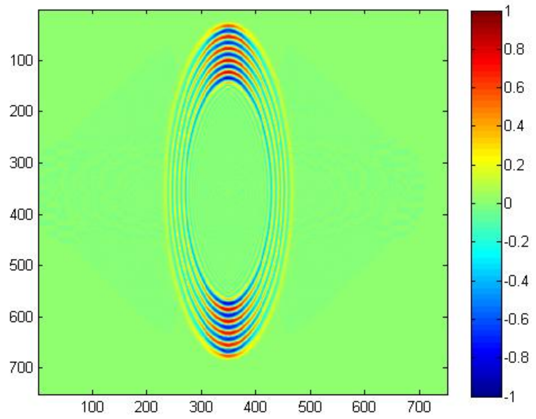

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3 Line sources

This case is not much different from the one above. When the source is kept vertically (along y),it's speed is supposed to be slower by a factor of sqrt(8),in the caseof TE. The response is shown below:

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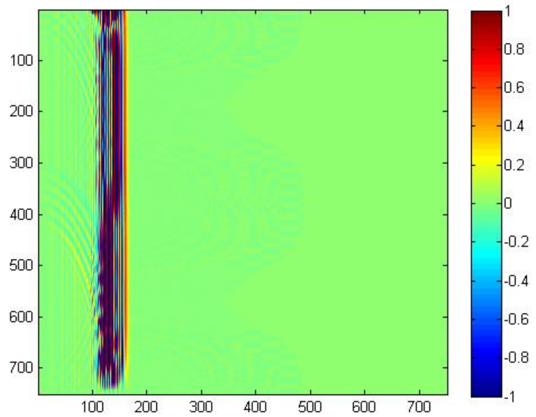

For the case of TM, it will be the same response as for the free space case: the light moves at the speed of light in vacuum.

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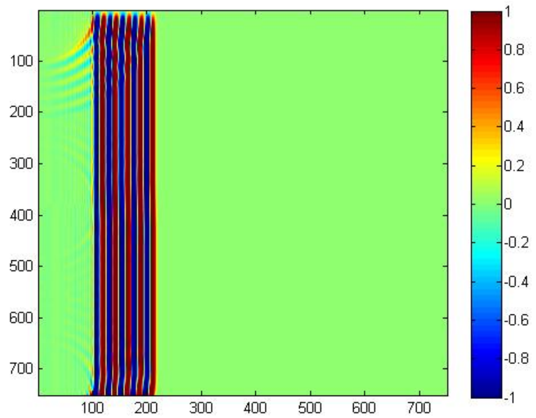

When the line source kept horizontally (along the x axis), the TE wave moves at the speed of light in vacuum, as epsilonx doesn't affect any of the equations. The wave is shown below:

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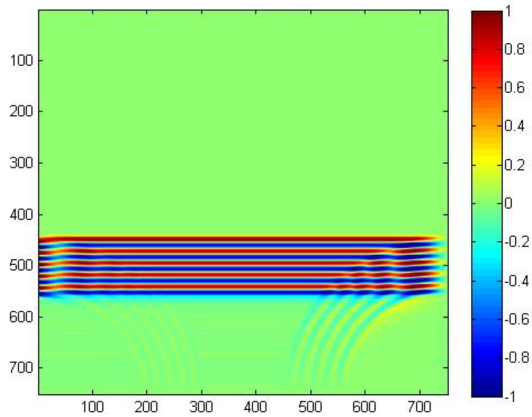

For the case of TM, the result is as shown below:

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