ESF Research Networking Programme NEWFOCUS

Analysis of multilayer lenses with circular polarization properties

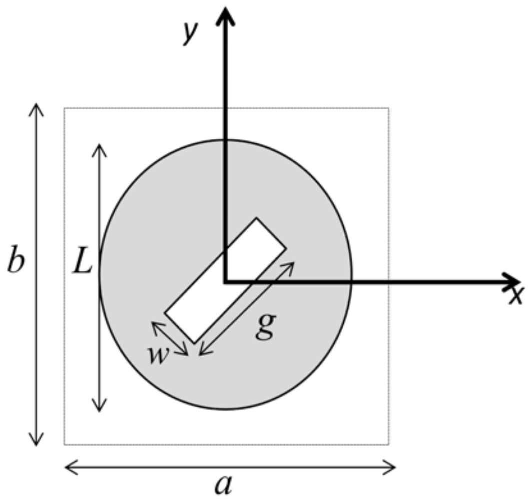
scientific report

This report describes the work carried out during the short visit to Dipartimento di Ingegneria dell'Informazione, Università degli Studi di Siena from May 04 to May 18. The purpose of the visit was to start working on analysis of multilayer lenses.

Main results

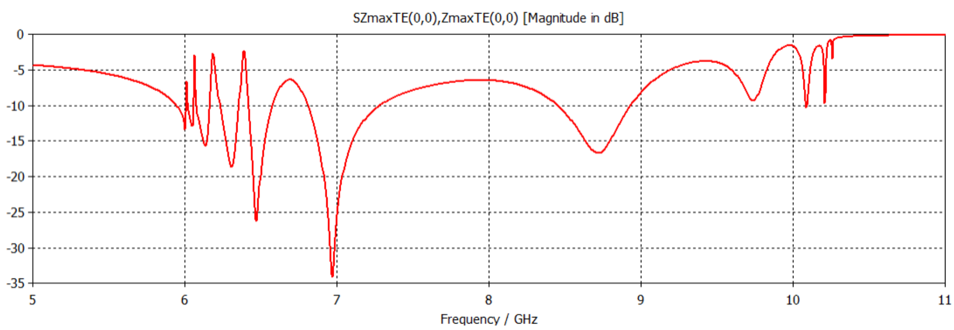
Anisotropic multilayer lenses represent important class of lenses used in microwave applications and optics. Apart from traditional lenses with isotropic layers, today anisotropic lenses are becoming more and more interesting due to their specific properties. One such property is polarization conversion and rotation of electrical field of incident electromagnetic wave. For example a linearly polarized wave may be converted to a circularly polarized wave by a lens which provides 90° difference in transmission phase between cross-polarized linear components. Idea is to stack layers which rotate phase by certain amount, and in the end provide necessary phase difference.

In our work we simulated one of those lenses.

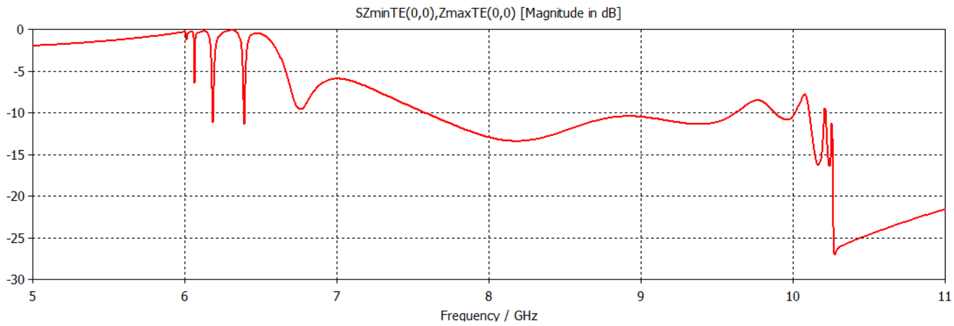


a=b= 10 mm
L= 9 mm
g=8 mm
w=1 mm
7 layers, 15 degrees between
In first layer slot is oriented in y direction

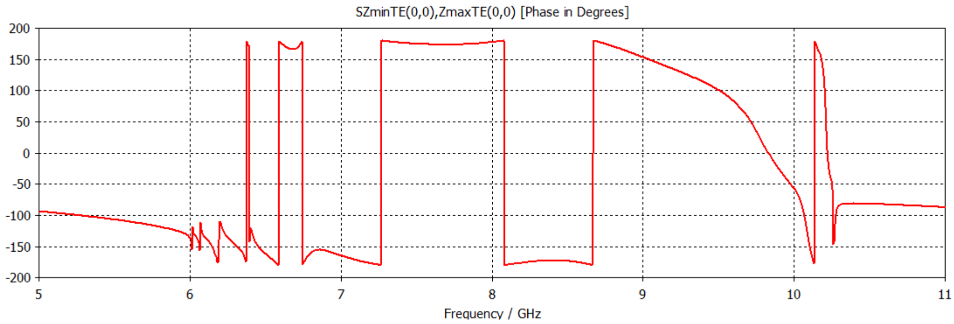
Our lense is constructed from 7 layers of FSS, and in each layer slot in the middle is rotatet for 15 degrees clock wisely. If incident electromagnetic wave is polarized in y direction we noticed circular polarization field at the other side of the lens.



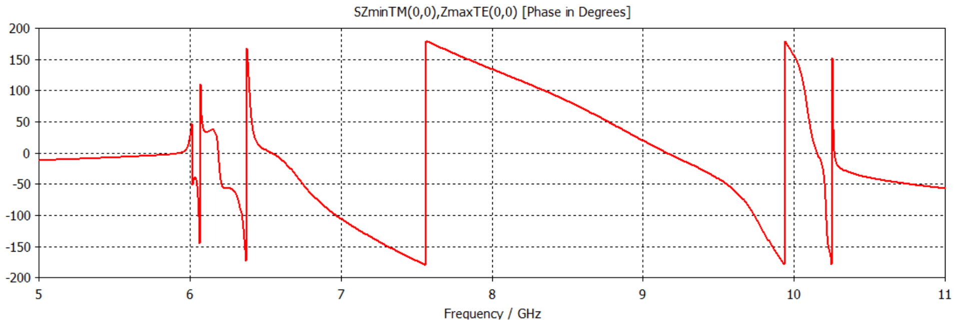
a)



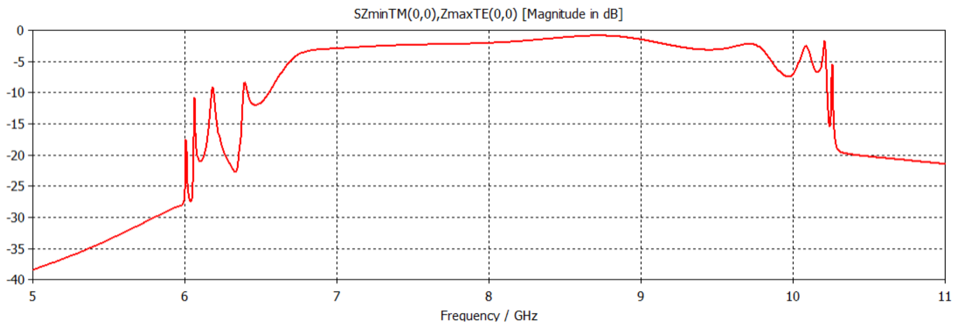
b)



c)



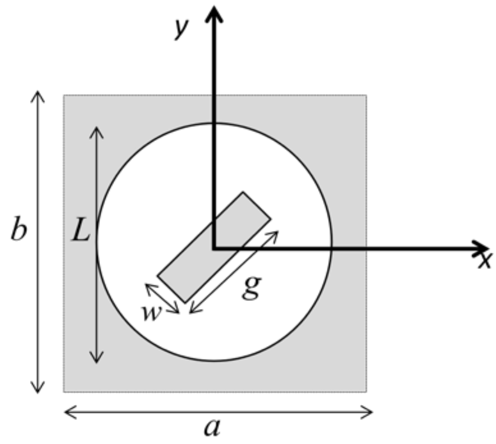
d)



e)

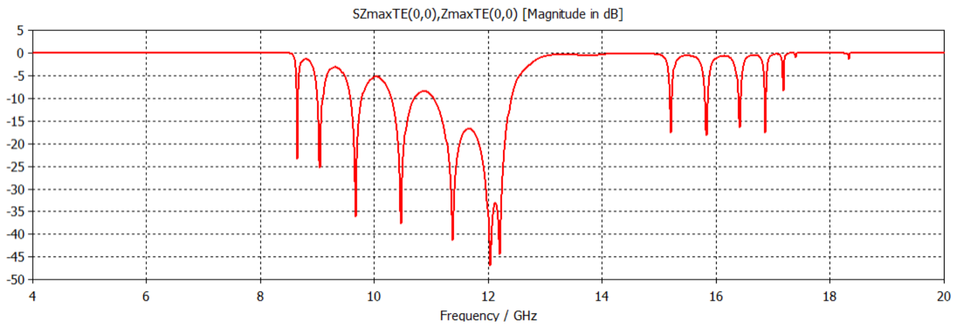
Picture 1. a) reflection coefficient for TE wave, b) transmission coefficient from TE wave to TE wave, c) phase of transmission coefficient from TE wave to TE wave d) phase of transmission coefficient from TE wave to TE, e) transmission coefficient from TE wave to TM wave

In first picture we see that reflection coefficient is very small in the range about 7 GHz. In that range on the other side of the lens we have both components with phase difference of about 70 degrees.

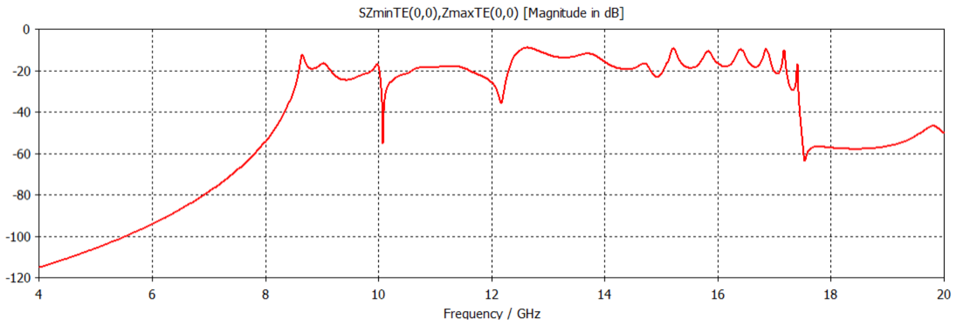


a=b= 10 mm
L= 9 mm
g=8 mm
w=1 mm
7 layers, 15 degrees between
In first layer dipol is oriented in y direction
TE is oriented in that direction too

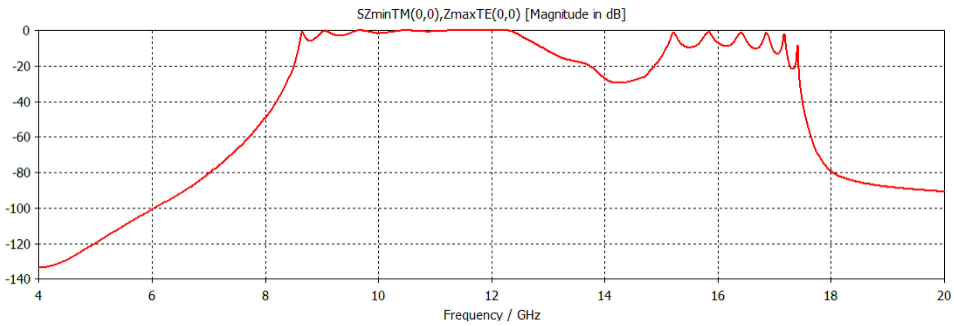
Our second geometry is complementary structure. We gain broader bandwidth but only rotational effect for y polarized incoming electromagnetic wave.



a)



b)



c)

Picture 1. a) reflection coefficient for TE wave, b) transmission coefficient from TE wave to TE wave, c) transmission coefficient from TE wave to TM wave

In this geometry we have large bandwidth (11.5 – 12.2 GHz), and lens behaves as a rotator.

In our future work idea is to find some geometry in which we will have larger bandwidth for a polarization effect, and to find simpler geometry for a rotational effect.