Metamaterial based Optical Complex Field Synthesis

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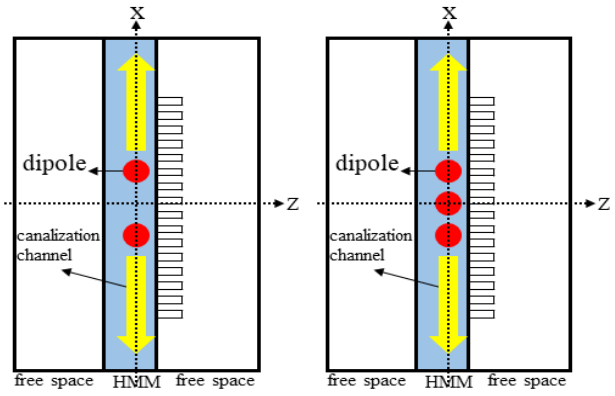
1. Introduction

The holographic display has recently garnered much attention as the next-generation image technology, and the research and development thereof is proceeding. In general, to generate a hologram, a spatial light modulator (SLM) is mainly used for amplitude or phase modulation, and a specific optical system must be additionally applied to eliminate DC or conjugate noise. Accordingly, the technology of complex modulation SLM has been continuously studied to reduce the volume of optical system and generate the holograms effectively. Also, Hyperbolic Metamaterial (HMM) has been actively researched because they possess the potential for broadband manipulation of the photonic density of states caused by the excitation of electromagnetic states with high-k modes [1]. Under that characteristics, the HMM will be a great advantage from the viewpoint of light extraction.

In this paper, the two dipole coupling structures using HMM is reported and the transmission and modulation characteristics of them are analyzed.

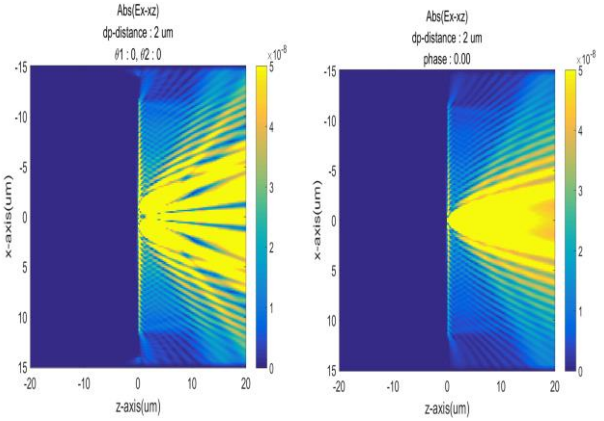
2. Simulation Methods



(a) (b)

Figure. 1. Simulation structures of (a) two phase-modulated dipole pair, and (b) three amplitude-modulated dipole pair

When each dipole pair responds to the HMM, a canalization channel phenomenon occurs, and light is extracted through the binary grating structures. A schematic diagrams of the coupling structures of the dipole for the complex modulation is shown in Figure 1. Figure 1 (a) shows a structure in which two phase-modulated dipoles are arranged in the HMM. Figure 1 (b) shows a schematic diagram of a structure in which three dipoles that can be modulated its amplitude using Burckhardt encoding in the HMM. The vertical permittivity and transverse permittivity of the HMM is $-(20+0.5i)^2$ and $(1+0.05i)^2$, respectively. And permittivity of the binary grating structure is $(1.5)^2$. We can achieve the amplitude modulation using the two phase-modulated dipoles and the three amplitude-modulated dipoles using Burckhardt-encoding, which can also be phase modulated, respectively. Therefore, the complex modulation is ultimately enable.



(a) (b)

Figure. 2. Simulation results of (a) two phase-modulated dipole pair and (b) three amplitude-modulated dipole pair

Figure 2 shows the field distribution obtained by FMM electromagnetic field analysis simulation for the schematic diagrams of Figure 1. The results of the field distribution in each simulation show that the modulation of the light wave.

3. Conclusions

In this paper, we analyze the modulation characteristics using combined dipoles in the HMM, and discuss simulation results, calculation efficiency and accuracy.

References

[1] J. S. Gomez-Diaz and Andrea Alu, “Flatland Optics with Hyperbolic Metasurfaces,” ACS Photonics, 3 (13), pp 2211–2224, 2016.