بسم الله الرحمن الرحيم

MONA MAGHRABY

شبكة المعلومات الجامعية

التوثيق الالكتروني والميكروفيلم

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التوثيق الإلكتروني والميكروفيلم

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قسم

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Optical Metasurfaces

A Thesis
Submitted in partial fulfillment of the requirements of a Master of Science degree in Electrical Engineering

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Statement

This dissertation is submitted to Ain Shams University for the degree of Master of Science in Electrical Engineering (Electronics and Communications Engineering).

The work included in this thesis was carried out by the author at the Electronics and Communications Engineering Department, Faculty of Engineering, Ain Shams University, Cairo, Egypt.

No part of this thesis was submitted for a degree or a qualification at any other university or institution.

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ABSTRACT

This thesis aims at introducing different optical metasurfaces specifically designed to achieve subwavelength focusing in the infrared range. Most of the plasmonic research in the literature has been directed towards the visible range and little attention was given to infrared metasurfaces and their applications. In this thesis, we have presented three different metasurfaces that can achieve sub-wavelength focusing in the infrared domain. The structures presented achieve either high focusing resolution or high transmission efficiency or extended mid-infrared bandwidth so they can satisfy the different critical requirements of different infrared applications. We study and compare their performance parameters across the wavelength and we also study the influence of the used metal's permittivity on the transmission performance. Those studies and comparison are meant to provide future designers an insight on how to design the metasurfaces that suit their performance requirements in the infrared range. They are also meant to make the design process easier.

Our aim was also to design those metasurfaces such that they would be easily and cheaply fabricated and integrated in infrared applications. We did this by using CMOS compatible and inexpensive materials such as copper and silicon. This is in contrast to the materials that were commonly used in visible plasmonics such as gold and silver or metamaterials.

The other goal of this thesis was to design a dielectric axicon zone plate metalens to be used in high sensitivity optical sensing as an example application. The axicon zone plate is compact, more efficient and easier to fabricate in comparison to the traditional bulky axicon. We made our designs specifically at the wavelength of 3.3 microns at which the absorption of CH_4 gas is maximum. We developed an ana-

lytical formulation for the intensity variation with the refractive index and concluded the condition to achieve maximum sensitivity.

Keywords: Infrared focusing, subwavelength focusing, nanoslits, metasurface, metalens, slit width modulation, plasmonic lens, planar lens, phase modulation, super focusing, super lens, plasmonics, Axicon lens, High sensitivity refractive index sensing, gas sensing, Bessel-Gauss beams, CH_4 gas sensing, Axicon zone plate.