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K N Toosi University of Technology
Faculty of Electrical Engineering
Center of Excellence in Computation and Characterization of Devices and Subsystems

The Second Iranian Conference on Engineering Electromagnetics (ICEEM 2014),
Jan. 8-9, 2014

Iranian Scientific Society of Engineering Electromagnetics

Nanoscale Temperature Sensor Based on Plasmonic Waveguides with Nanocavity Resonator

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ABSTRACT— **In this paper, the performance of a nanoscale temperature sensor in two-dimensional plasmonic waveguides with nanocavity resonator has been investigated. The results are based on the theoretical relations describing the nanocavity resonator. The results demonstrate the linear correlation between the resonance wavelengths of the nanocavity of the sensor, the refractive index of the material inside the nanocavity, and therefore, the ambient temperature. The resolution of the sensor depends on the wavelength resolution of the detection system. This sensor can be employed in diverse systems such as chemical and bio systems.**

KEYWORDS: Nanocavity, plasmonic, refractive index, resonator, temperature sensor.

I. INTRODUCTION

The precise measurement of temperature variations of fluid is imperative for variety of devices and systems, such as chemical reactors and biosensors. Optical sensors which convert the quantity of being measured to one of the features of a lightwave can provide high speed and accurate instrument for realizing sensors such as temperature sensors [1]. On the other hand, the great attention to nanotechnology which is the study of manipulating matter on an atomic and molecular scale has grown the necessity for nanoscale temperature sensors [2]. By utilizing the Surface Plasmon Polaritons (SPPs), which are waves excited on the surfaces of metal-dielectric interfaces and attenuate exponentially perpendicular to the interface, some suitable sensors like Surface Plasmon Resonance (SPR) sensors can be realized [3]. So far, various SPR sensors have been studied and developed to sence variations of different quantities [4, 5].

In some SPR sensors, the changes in some structural parameters of the plasmonic resonators cause changes in resonance wavelength of the structure and provide an approach for measuring the quantity under sense. Therefore, an optical temperature sensor based on SPR, which can be shown to be a promising approach to be used in the development of chemical, physical, and biomedical applications, is proposed [6].

In our proposed sensor, the resonance wavelength is extremely sensitive to the refractive index of the matreial inside the nanocavity, which can be a liquid, gas, or solid [7].

The resonance wavelength, or the refractive index of the nanocavity, can be affected by the concentration of chemicals, humidity,