Generalized Surface Plasmon Resonance Sensor Using Metamaterials and Negative Index Medium

(Speacial session in Metamaterials)

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Surface plasmon resonance has been known for a long time and has been used for chemical sensors and in remote sensing systems. It makes use of a prism and a thin metal layer deposited upon the prism. The p-polarized (TM) reflected light exhibits a sharp dip at the angle corresponding to the surface plasmon between the metal and the bulk material. This resonance occurs due to the negative dielectric constant of the metal, such as gold or silver, at optical frequencies.

In this paper, we explore the use of the NIM (negative index medium), and more generally metamaterials, to produce the surface plasmon resonance at microwave frequencies. First, we discuss the surface wave (surface plasmon) modes between NIM and the dielectric. This requires the study of all wave types which may exist between the medium with arbitrary e and m and the ordinary medium. We discuss the classification of wave types. In particular, we discuss the regimes in an m-e diagram where the forward and backward surface waves exist. These regimes give rise to the surface waves, and the reflection coefficient exhibits a sharp dip at this particular angle, similar to the conventional optical surface plasmon resonance sensor.

We clarify the relationships between the p (TM) and s (TE) polarizations. The fields inside NIM are examined, as well as the interesting behaviors of the Poynting vectors, pointing to the opposite direction in the inside and outside of NIM. We discuss the angular and frequency sensitivities of this phenomenon and difficulties in implementing this for practical applications.