Sensing Mechanism in Optical Antennas

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Optical antennas are structures that convert freely propagating radiation into localized energy and vice verse. Using optical antennas, it is possible to control visible light at sub-wavelength scale. Optical Antennas are analogous in operation to the regular Radio Frequency (RF) antennas but they operate at visible-near infrared (VIS-NIR) light wavelengths. Optical Nano Antenna (ONA) are composed of nanoparticles that are placed on a dielectric substrate that is transparent. The particles are designed such that the system would resonate at certain desired wavelength. . The particles and the ONA form a combined system, which means that any changes in the particles will affect the resonance characteristics of the system. ONA particles are usually made of metals similar to their RF microwave counterparts. However, the metal particles interact with visible light differently than they interact with RF and microwave radiation. At optical frequencies, metals like gold and silver act as a plasma of electrons. ONAs, which are metal nano-structures give rise to Localized Surface Plasmon Resonance (LPSR) in the visible and Infrared (IR) light spectrum. LSPR is a very important phenomenon as compared to propagating Surface Plasmon Resonance (SPR). Therefore, for localized change in the refractive index, caused by analyte such as gases, it becomes important to have a very small volume in which the electric field is confined.

In this paper we will present the sensing mechanism in ONAs and show the results of using fabricated optical nano antennas as sensors for four types of gas molecules. An optical nano antenna was fabricated using dipole structure for the design of the antenna. Gold was used as the nano particles. The measurements show that the ONA sensor is sensitive to different analyte and shift in the resonance is proportional to the concentration of the analyte.

Some of the shifts are blue shifts and some other are red shifts. This depends on the mechanism of absorbing the molecules and on the absorbent on top of the ONA. ONA works on the principle of the plasmonics but it is important to understand the physics behind the various outputs that are observed for different analytes by different sensors.