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Improved Eye Sight Light Matter Interaction by Using a Hybrid Plasmonic Photonic Microcavity

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Introduction

Plasmatic materials have been used to demonstrate some fascinating phenomena due to their improved light-matter interaction and high sensitivity. The relatively broad resonance line and the absence of referencing to a known source of absolute resonance make surface Plasmon resonance, which is of particular interest for sensing applications and where resonance is obtained for a particular combination of angle and wavelength of the incident light, somewhat constrained [1]. We address these shortcomings by making use of the connection between plasmatic and molecular resonance in a hybrid SPR and acetylene device. While acetylene provides a precise and narrow resonance in the telecom band, the coupled system reaps the benefits of the SPR's increased light-matter interactions, angular sensitivity, and compactness.

Our hybrid system is extremely sensitive to even the smallest changes in incident angle due to these properties. SPR is extremely sensitive to changes in refractive index due to acetylene's high degree of dispersion. When combined with the telecom band's narrow transition line of the acetylene transition line, this makes it possible to create a feedback signal for laser stabilization with a small volume. In addition, we have demonstrated an angular sensor with high sensitivity and accuracy and angular resolution on the order of micro radians [2].

Description

Plasmatic devices have gained popularity in recent years due to their inherent advantages and capacity to limit light down to the nanometer level. Due to the increased electromagnetic field that is present in close proximity to metallic surfaces, exciting phenomena such as strong nonlinear interactions, an increased spontaneous emission rate, and local interactions with single quantum emitters can be observed [3].

Plasmatic phenomena, particularly surface Plasmon resonance, are also highly appealing for sensing applications. Sadly, their only performance limitation may be the enormous losses that cause such devices to have very broad resonances. Plasmatic devices are also less effective for high-accuracy applications because the plasmatic resonance is affected by external factors. On the other hand, gas molecules like carbon monoxide and acetylene, as well as alkali atomic vapours like rubidium and caesium, are distinguished by their extremely precise transition linewidths. Although changes in temperature and pressure can alter the molecular transition, changes in the optical transition caused by temperature-driven pressure changes are minimal once acetylene is sealed in a reference cell at ambient temperature. As a result, they are frequently used as standards for the laser stabilization frequency. Laser stabilization is needed for atomic clocks, spectrum analyzers, and metrology.

The integration and miniaturization of atomic vapour cells in the form of integrated Nano photonic-atomic devices, such as ant resonant reflecting optical waveguides, hollow core fibers, the atomic cladded wave guide, the atomic cladding mirroring resonator, and the atomic cladded interferometer, has received a significant amount of attention in recent years [4]. A connected plasmatic-atomic device has also been made available. The acetylene molecule is frequently utilized as a reference source for stabilizing light sources in the telecom range, whereas atomic vapours like rubidium fulfill the requirement for stable sources in the near-infrared frequency range. Indeed, hollow core photonic crystal fibers loaded with acetylene have been used to demonstrate molecular spectroscopy in the telecom sector [5].

Conclusion

By combining the advantages of plasmonics to achieve high sensitivity, strong field confinement, and enhanced light-matter interactions at the nanoscale with the advantages of the acetylene molecule to achieve an accurate and narrow linewidth in the telecom band, we present what we believe to be the first integrated coupled plasmatic-acetylene system. We are able to reduce the size of our integrated device while simultaneously reducing the amount of time that light interacts with matter and significantly improving the performance of the SPR system. We are able to alter the coupled system's narrow line shape and monitor minute changes at the telecom regime using our plasmatic-enhanced light-molecular interaction method in a gaseous medium.

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Conflict of Interest

None.

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