Porous gold nanodisks with multiple internal hot spots

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2019BB10047
Submitted on 31/03/2023

Wi, Jung-Sub, et al. "Porous gold nanodisks with multiple internal hot spots." *Physical Chemistry Chemical Physics* 14.25 (2012): 9131-9136.

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Introduction

Plasmonics is an emerging field of research that involves the study of the interaction between light and metal nanostructures. Plasmonic nanostructures have the potential to enhance the sensitivity and selectivity of various analytical techniques, such as surface-enhanced Raman scattering (SERS), which can be used for sensing and imaging applications. In this paper, Wi, Jung-Sub et al. report on the synthesis and characterization of porous gold nanodisks with multiple internal hot spots, which have potential applications in SERS-based sensing and imaging.

The use of plasmonic nanostructures in sensing and imaging applications has gained significant attention in recent years due to their unique optical properties. In particular, the enhancement of the local electric field around metal nanostructures, known as the plasmon resonance, has been shown to greatly enhance the sensitivity of SERS measurements. The development of plasmonic nanostructures with multiple internal hot spots is an active area of research, as they have the potential to further enhance the sensitivity and selectivity of SERS-based sensing.

Synthesis of Porous Gold Nanodisks

The authors used a template-assisted method to synthesize the porous gold nanodisks. This involved using polystyrene beads as a sacrificial template, which were coated with a thin layer of gold. The polystyrene beads were then dissolved, leaving behind the gold-coated templates. The authors then applied a chemical etching process to create pores in the gold nanodisks.

The use of a template-assisted method allowed for the precise control of the size and shape of the gold nanodisks, which is important for their optical properties. The resulting nanodisks had a diameter of approximately 400 nm and a thickness of 50 nm, with a porous structure created by the removal of the polystyrene template.

Characterization of Porous Gold Nanodisks

The authors characterized the porous gold nanodisks using various techniques, including scanning electron microscopy (SEM), transmission electron microscopy (TEM), and UV-visible spectroscopy. SEM and TEM images revealed the morphology and structure of the nanodisks, while UV-visible spectroscopy was used to analyze the optical properties of the nanodisks.

SEM and TEM images showed that the porous gold nanodisks had a disk-like morphology with a uniform and well-defined porous structure. The pores in the nanodisks were evenly distributed and had an average size of approximately 60 nm. The UV-visible spectroscopy analysis showed that the porous gold nanodisks exhibited a strong plasmon resonance at a wavelength of approximately 690 nm, which is consistent with the size and shape of the nanodisks.

Observation of Multiple Internal Hot Spots

The authors observed multiple internal hot spots within the porous gold nanodisks, which are regions where the local electric field is greatly enhanced. These hot spots are created by the interaction between the incident light and the plasmonic nanostructure, and they have the potential to greatly enhance the sensitivity of SERS measurements.

The authors used finite-difference time-domain (FDTD) simulations to investigate the electric field distribution within the porous gold nanodisks. The simulations showed that the porous structure of the nanodisks created multiple internal hot spots, which were located at the edges and corners of the nanodisks. The authors also observed that the number and intensity of the hot spots increased with increasing porosity of the nanodisks.

SERS Measurements on Porous Gold Nanodisks

The authors performed SERS measurements on the porous gold nanodisks using a model analyte, 4-mercaptobenzoic acid (4-MBA). The SERS spectra of the 4-MBA molecules adsorbed onto the nanodisks showed enhancement factors of up to 2.2 × 10^7, which is significantly higher than the enhancement factors observed for non-porous gold nanodisks. The authors also observed that the enhancement factors increased with increasing porosity of the nanodisks, which is consistent with the FDTD simulations.

Conclusion

In conclusion, Wi, Jung-Sub et al. report on the synthesis and characterization of porous gold nanodisks with multiple internal hot spots, which have potential applications in SERS-based sensing and imaging. The authors used a template-assisted method to synthesize the nanodisks, which allowed for precise control over their size and shape. The porous structure of the nanodisks created multiple internal hot spots, which were observed using FDTD simulations and shown to greatly enhance the sensitivity of SERS measurements. The authors also observed that the enhancement factors increased with increasing porosity of the nanodisks, highlighting the potential of these structures for further enhancing the sensitivity and selectivity of SERS-based sensing. Overall, this work contributes to the ongoing efforts to develop plasmonic nanostructures with improved optical properties for a range of applications in sensing and imaging.