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Streszczenie w języku angielskim

Plasmonic coupling between Quantum Dots and silver nanowires in spatially controlled assemblies

The rapid advancement of quantum technologies has led to the development of complex systems composed of coupled nanomaterials. One such system is the Majorana hybrid structure, which utilizes single quantum dots precisely positioned at the ends of nanowire. Due to the intricate interactions between these nanomaterials, constructing such systems require to be repeatable and accurate to ensure that the coupling effects translate into the desired functionality. These interactions are observed in hybrid systems where synergistic effects arise from the organized arrangement of nanomaterials. Consequently, various techniques have been developed to achieve spatial organization of hybrid systems with controlled geometries. Notably, Microsoft recently unveiled the Majorana 1 chip, intended for use in constructing quantum computers, highlighting the growing importance of precise nanomaterial positioning at the nanometric scale.

Designing and investigating hybrid systems is inherently interdisciplinary, integrating knowledge from chemistry (surface modification), physics (studying interactions between nanomaterials), nanotechnology (synthesizing nanomaterials), and mechanics (controlling the positioning of nanomaterials within hybrid systems). This combination of disciplines enables the construction of hybrid systems and the exploration of previously unknown interactions between selected nanomaterials.

This dissertation focuses on developing techniques and examining the interactions between silver nanowires and quantum dots within hybrid systems of controlled geometry. The chosen materials facilitate the study of interactions using light. The developed technique allows for the arrangement and investigation of coupling between nanomaterials in configurations that have not been previously realized.

From the perspective of nanomaterials used in constructing hybrid systems, silver nanowires are particularly intriguing due to their plasmonic excitations when exposed to light. This is attributed to their diameters, typically around 100 nm. Additionally, their lengths, often reaching several tens of micrometers, make them observable via optical microscopy. Beyond their capability to transfer energy over micrometer-scale distances, silver nanowires also exhibit mechanical robustness, allowing for their manipulation across surfaces without

damage. The second nanomaterial employed in constructing hybrid systems are quantum dots. By adjusting the core diameter of a quantum dot, one can modify its energy gap, enabling emission of light at specific wavelengths. This tunability allows for matching the emission of quantum dots to the plasmonic resonance of silver nanowires, promoting efficient coupling and energy transfer within hybrid systems.

The primary objective of this work was to investigate the plasmonic coupling in hybrid systems of controlled geometry, comprising quantum dots and silver nanowires, using optical techniques. A critical aspect in studying coupling within these systems was ensuring the reproducibility of the relative positioning between silver nanowires and droplets containing quantum dots in desired configurations. This dissertation also presents a technique for depositing individual quantum dots at selected locations on a surface.