Cross-Sectional Shape of Gold Nanopillars Directly Affects the Number of Single Photon Emission Sites in Deformed WSe2

Uysal, Ada (School: Ossining High School)

Two-dimensional semiconducting transition metal dichalcogenides (TMDC) are at the center of recent research regarding optoelectronic devices, such as single photon emitters, due to their unique optical and electrical properties. To harness these properties, material deformation via nanopillars has been utilized in past research, however, these nanopillars have been largely restricted to quadrilateral structures due to limitations from etching technologies, leading to a lack of knowledge on the influence of varied geometries on single photon emission. Therefore, this study analyzed the relationship between the geometry of nanopillars and the count of single photon emission sites using photoluminescence spectroscopy measurements. Bilayer samples of WSe2 were exfoliated and transferred onto gold nanopillar substrates consisting of six varied nanopillar geometries. PL spectroscopy measurements were performed on WSe2 samples in a 4k cryogenic cooler to analyze the counts of single photon emission sites relative to a nanopillar subregion. We found that the geometric aspects of the cross-sectional geometry of these nanopillars were directly related to the number of single photon emission sites present. Specifically, with the equilateral triangle pillars, the WSe2 displayed record-high photon emission intensities for a bilayer sample – 12kHz at OD2 – presenting a promising alternative for a cheaper and more powerful alternative for optoelectronic applications. These findings allow an increased degree of control and flexibility of single photon emission sites for optoelectronic and nanophotonic devices such as field-effect transistors, photovoltaics, and cryptographic configurations while also providing a promising alternative to the current conventional nanopillar models.