Enhancing Brightness of Microelements Through Plasmonic Nanostructure Coupling With Fluorescent Molecular Systems

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Recent advancements in surface plasmon (SP) structures have led to the utilization of metallic hole arrays for color generation and filtering, offering reliability and color tunability. These structures, which can be manufactured in sub-micron sizes, are instrumental in achieving high pixel densities crucial for enhancing the clarity, sharpness, and overall quality of displayed images. However, conventional SP-based pixels suffer from limitations such as low brightness and only transmitting light rather than emitting it, thereby restricting the dynamic range and contrast of the technology. In this study, we aimed to address the brightness issue of hole array-based structures by coupling SP with a molecular system. By introducing fluorescent molecules in close proximity to the plasmonic structures through the deposition of ultrathin layers, we sought to enhance the brightness. These layers were created utilizing a novel thin film platform known as Nano-Bead Emitters (NBE). NBE facilitates the fabrication of thin, highly homogeneous fluorescent layers on various surfaces using a wide range of molecules, including those typically unable to form emitting thin films. We developed colored NBE based on bright emitting molecules emitting at the red color. Hole arrays with varying periodicities were fabricated to be coupled with the electronic transitions of these emitting molecules. The functional hybrid structures demonstrated increased transmittance and significantly higher emission, indicating potential applications as brighter optoelectric elements and platforms for energy transfer studies.

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