## Metasurfaces-Enabled Ultra-Bright Single Photon Sources

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**Abstract:** In recent years, the rapid advancement of quantum information technology has been underscored by the experimental validation of quantum supremacy. The establishment of a reliable and fast quantum system relies not only on quantum circuits, detectors, and algorithms but also significantly on the quantum source. Optical quantum communication and computing systems requires single-photon sources that are bright, pure, indistinguishable, and available on-demand. Single quantum dots, often termed quasi-atomic systems, stand out as promising single-photon sources due to their superior emission properties. Yet, a significant portion of light from semiconductors generally remains trapped and can't escape into the ambient air without help from photonic structures. In this work, we introduce a unique structure designed for efficient photon extraction into the air. Our design pairs a single quantum dot (SQD) with a dielectric metasurface backed by a metal reflector. This setup modifies the optical mode inside the host material, directing the SQD-emitted light to exit normally. Our results demonstrated approximately 90% extraction efficiency and 86% collection efficiency within a relatively low numerical aperture (0.5 NA). Additionally, the extracted light from our design can seamlessly interface with a single-mode fiber, further enhancing photon collection efficacy.