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## *Coupling Multi-Colour NAs and QDs for the Efficient Generation of Single THz Photons*

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ABSTRACT

This work proposes an efficient wavelength-tunable THz single-photon (SP) source or, more concisely, a THz superemitter and researches the components necessary to achieve this goal. The main focus is on finding suitable SP sources and a means to tune the photon energy as well as increase the emitter's SP emission rate. Considering various SP sources, the quantum dot is found to be the most suitable quantum emitter and the compound multi-colour nano-antenna (NA) the most suitable enhancement device, as it provides the ability to electronically control the emission wavelength via the quantum confined Stark effect as well as enhance the luminescence via the Purcell effect.

The experimental side of this work is focused on fundamental research and building know-how in the field of plasmonics. To this end, we developed a novel spectroscopy technique (RoPoSpec) in order to probe the localised surface plasmon resonance (LSPR) spectrum of single NAs. RoPoSpec rotates the linear polarisation of a probe beam and measures the intensity modulation caused by the linearly polarised antenna to quantify the extinction cross-section. RoPoSpec was used to carry out an in-depth materials study to understand how the LSPR behaves depending on the materials the antenna as well as the antenna's environment are composed of. Knowledge of the influence various material compositions have upon the LSPR is particularly important, as NAs are very sensitive to their immediate environment and the use of some materials in the antenna's proximity may be unavoidable. From the materials study, an effective medium model was constructed to predict the effect various material combinations have upon the antenna's performance.

Furthermore, self-assembled InAs/GaAs as well as colloidal PbS quantum dots (QDs) are studied as potential emitter candidates. With self-assembled QDs it is essential to reduce the capping layer as far as possible to increase the coupling strength between the NA and the InAs nano-crystal. Therefore, the impact of capping-layer-etching upon the dot luminescence was studied.

The final experiments of this work are concerned with functionalising NAs with QDs by means of fabrication upon the GaAs capping layer and selectively adhering colloidal PbS dots to the antennas' feed gaps by means of focused electron beam induced deposition as well as through nano-lithographic positioning of PbS clusters. Here, nano-lithographic cluster positioning was found to be the most effective technique to deposit dots mainly into the antenna's feed gap and thus improve the contrast between the luminescence background caused by residual dots outside the enhancement volume and the enhanced luminescence of dots within the antenna gap.