Atomically thin quantum light-emitting diodes

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Integrating single-photon sources into on-chip optical circuits is a challenge for scalable quantum-photonic technologies such as quantum information, quantum key distribution and quantum lithography [1]. Despite a plethora of single-photon sources reported to-date [2], all-electrical operation, critical for applications such as on-chip photonic circuits, has been reported for only a few [2]. The attractiveness of single-photon sources in layered materials [3-6] stems from their ability to operate at the fundamental limit of single-layer thickness, foreseeing high photon emission rate and providing the potential to integrate into conventional and scalable high-speed optoelectronic device systems. We use light emitting devices realized by vertical stacking of graphene, hexagonal-BN few layers thick and mono- and bilayer transition-metal dichalcogenides (TMDs) and achieve charge injection from graphene into the TMD layer containing optically active quantum dots. We demonstrate that layered materials enable all-electrical single-photon generation over a broad spectrum [7]. We demonstrate for the first time that quantum emitters reported in WSe_2 can operate electrically [Fig.1], paving the way towards a new class of quantum light emitting devices. We further report all-electrical single-photon generation in the visible spectrum from quantum emitters in a new material, WS_2 (Fig. 2). I will also discuss our further developments on scalability and charge control over the single emitters to show that 2d materials are a platform for fully integrable and atomically precise quantum photonics device technologies.

References

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Figures

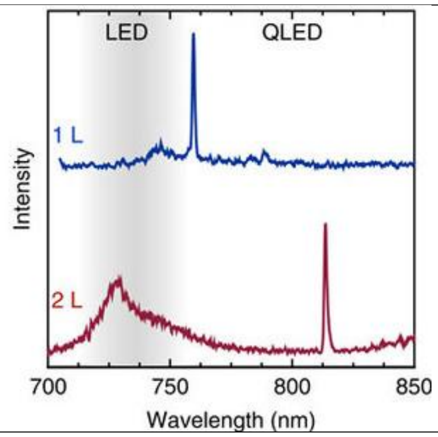

Figure 1: electroluminescence spectrum from monolayer (top) and bilayer (bottom) WSe_2. The shaded area highlights the bulk exciton emission

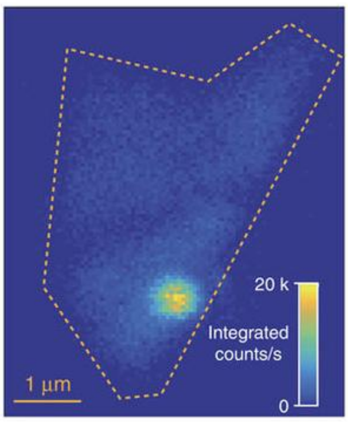

Figure 2: intensity scan showing highly localized quantum electroluminescence from a WS_2-based LED