Strong Electrostatic Control of Excitonic Features in MoS2 by a Free-Standing Ultrahigh-κ Ferroelectric Perovskite

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Recently, research interest in freestanding complex oxides has grown rapidly. These oxides are offering advanced functionalities, unthinkable for standard 2D dielectrics (such as hBN) and give rise to rich new physics as well as improved electronic device systems. Specifically, the high-κ ferroelectric perovskite $BaTiO_3$ (BTO) has drawn attention in its freestanding form for future transistor and memory applications [1,2]. After the growth and its delamination, BTO can be transferred to any substrate using standard Van der waals transfer techniques. By combining it with monolayer MoS_2, we are able to control the excitonic behavior by electrostatic gating the 2D semiconductor through BTO. Photoluminescence measurements at room temperature reveal highly tunable emission of the A exciton and its trion, as well as tunable trion binding energy over a small range of gate voltage, with the possibility of introducing remanent exciton behavior due to BTO's ferroelectric nature [3].

References

[1] S Puebla, **T Pucher** et al., Nano Letters, 22(18) (2022)
[2] G Sánchez-Santolino et al., Nature, 626(7999) (2024)
[3] **T Pucher**, S Puebla et al., Advanced Functional Materials, 34(52) (2024)

Figures

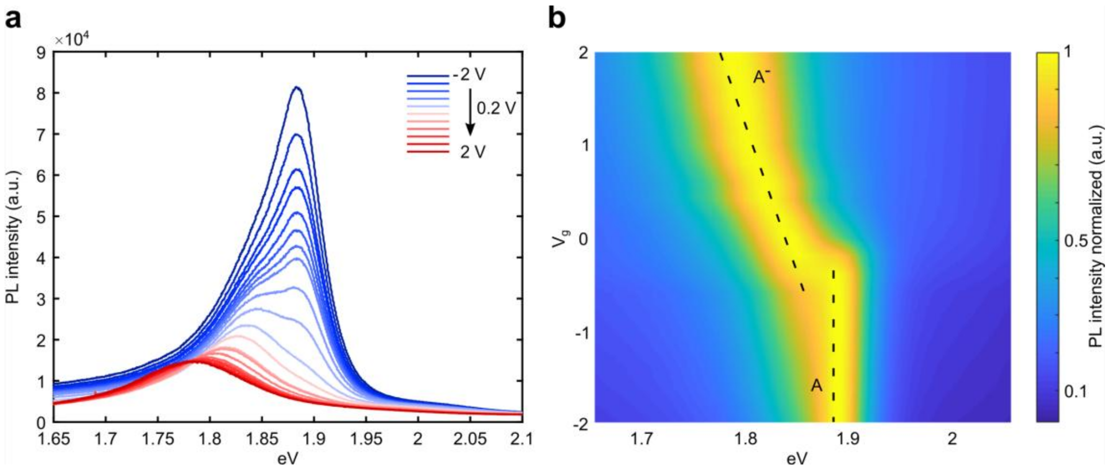

Figure 1: Tunable emission of MoS2/BTO device at room temperature. a) Photoluminescence spectra of MoS2 on top of BTO for different bias voltages (gate voltage steps of 0.2 V). b) Color map of the exciton emission shift.