# Transport properties of a two-dimensional PbSe square superstructure in an electrolyte-gated transistor

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Colloidal semiconductor nanocrystals have gained interest because their optical and electronic properties can be tuned by varying shape, size and composition. Recently, 2D square and honeycomb superstructures of lead- and cadmium-chalcogenide quantum dots (QDs) have been prepared. These superstructures are formed by assembling PbSe nanocrystals in a monolayer at a toluene suspension air/interface after which the nanocrystals attach via their four vertical {100} facets [1],[2]. Theoretical studies show that these 2D systems have profoundly distinct band structures compared to other continuous nanosheets with the appearance of Dirac cones in the case of the honeycomb structure [3],[4]. Strong electronic coupling via the atomic connections of the QDs in the superstructure may result in a higher electron mobility compared to the self-assembled lead chalcogenide QDs that are less strongly coupled due to the presence of (in)organic ligands [5].

In this work, we use electrolyte-gated transistors (Figure 1a) to study the optoelectronic properties and transport characteristics of 2D PbSe superstructures [6]. The potential of the gate electrode determines the Fermi level with respect to the conduction band (CB) or valance band (VB) of the superstructure. First, to monitor the stability of the superlattice under electron injection we measure the differential capacitance as a function of gate voltage. From the total injected charge and an estimation of the number of nanocrystal sites in the gated part of the PbSe superlattice, we calculate charge density of the superstructure. Second, the conductivity of the network is measured as a function of the Fermi level position. Finally, the electron mobility of the system is calculated from the measured conductivity and charge density.

As an alternative method to quantify electron injection into the PbSe superlattice, the optical absorption measurement is done while sweeping the gate potential. Furthermore, the position of the Fermi level can also be obtained by measuring the inter-band light absorption quenching which monitors the precise occupation of the bands independent of interband traps (Figure1b).

**(a)** **(b)**

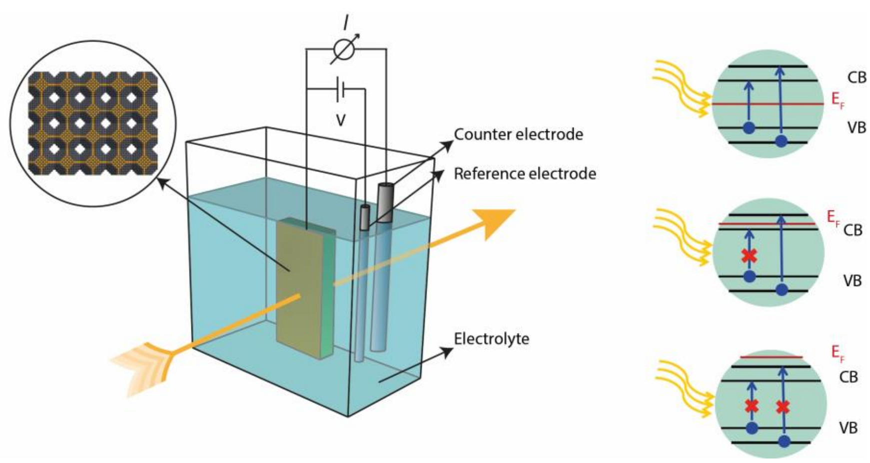


**Figure. 1** a) electrolyte gated transistor, b) Interband light absorption quenching

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