# Polaron Effect on Electronic Transport of Colloidal Quantum Dot Ambipolar Field-Effect Transistors

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Colloidal quantum dots (CQDs) are nanometer size single crystal inorganic materials, which are stabilized by organic molecules to make them soluble, ideal for solution-processable electronics. The size-dependent quantum confinement effect makes these semiconducting materials to have analogous properties to organic materials. Despite CQD assemblies have been proven ideal for photovoltaics and displays applications, many aspects of the charge carrier transport properties have not been investigated yet.

Here we show that the electronic transport in the assembly of CQDs are strongly influenced by the polaron of the insulator dielectric. Ambipolar field-effect transistors of PbS CQDs have been fabricated using various kinds of polymer dielectric that can be spin-coated on top of the QD film without changing its properties. Among them are three types of high-*k* ferroelectric polymers. All of these polymers can support the ambipolar transport operation of the PbS QD FETs. At room temperature, the charge carrier mobilities of these FETs do not differ so much from the state-of-the-art.[1,2,3] However, decreasing the FET operation temperature, signify the influence of the usage of dielectric towards the charge carrier mobility values. The higher the dielectric coefficient of the insulating polymers, the lower the holes and electron mobility values. These findings can be attributed to the Fröhlich polaron formation at the semiconductor/insulator interface. The observation in nanostructured inorganic semiconductors might indicate that this phenomenon is not only limited for organic semiconductors,[4] but might be more general occurrence in systems having modest carrier mobility values.

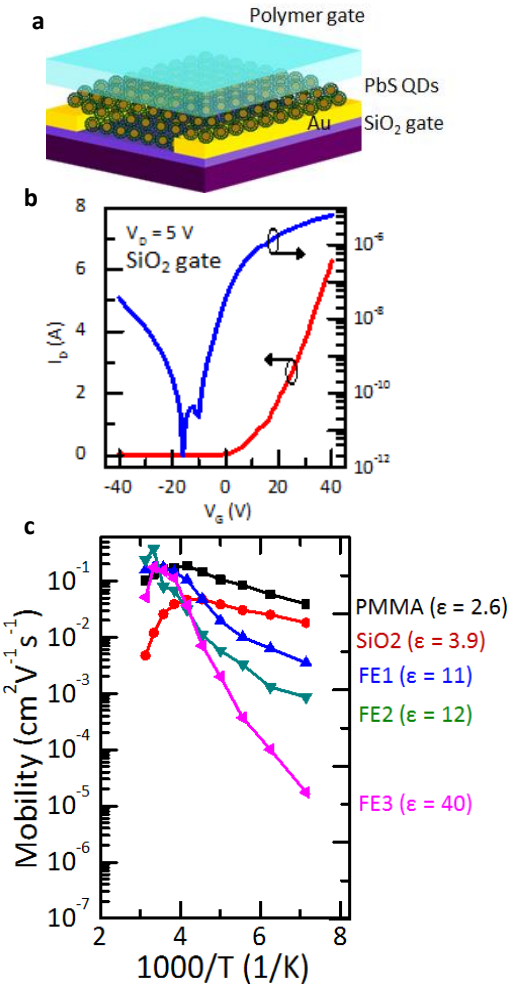


**Figure 1 (a)** Schematic of the ambipolar FET of PbS QD using polymer gate dielectric. **(b)** n-channel $I_D$-$V_G$ transfer curve of the FET on $SiO_2$ demonstrating ambipolar transport. **(c)** Temperature-dependent electron mobility of the FETs using various polymer insulators.

References:[1] S. Z. Bisri, et al. *Adv. Mater.* **26**, 1176 (2014); [2] S. Z. Bisri, et al. *Adv. Mater.* **25**, 4309 (2013); [3] M. I. Nugraha, S. Z. Bisri, et al. *Adv. Mater.* **27**, 2107 (2015); [4] I. N. Hulea, et al. *Nature Mater.* **5**, 982 (2006)