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Ionic gating with Li-ion conductive glass ceramics

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Ionic liquid gate enables novel experiments for observation of fascinating physical phenomena, such as gate-induced superconductivity [1] and the spectroscopy of the band gap of 2D semiconductors [2]. However, since the ionic liquid covers the surface of the device, there are some limitations to the experimental techniques that can be used in combination with it, such as ARPES and STM.
Here, we discuss a new type of ionic gate in the shape of Li-ion conducting glass-ceramics. With this new material, our goal was to achieve similar carrier densities and electric fields with respect to the liquid, leaving the surface of the device accessible [3]. Nevertheless, several issues were still unsolved. Specifically, the high leakage current present for positive gate voltages hindered electron transport. In addition, the reference electrode, whose task is to measure the gate voltage delivered to the device, impaired the correct estimation of the band gap due to its position far away from the semiconductor channel. In fact, there is non-uniform distribution of the applied gate voltage across the substrate as a result of its composition. To overcome these limitations, we reduced the leakage current via the deposition of SiO2 underneath the metal electrodes, and we implemented a local reference electrode.

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[2] Braga, Daniele, et al. "Quantitative determination of the band gap of WS2 with ambipolar ionic liquid-gated transistors." Nano letters 12.10 (2012): 5218-5223.

[3] Philippi, Marc, et al. "Lithium-ion conducting glass ceramics for electrostatic gating." Applied Physics Letters 113.3 (2018): 033502.