FLUID-FET: An Ionic Switch for Biological and Chemical Species

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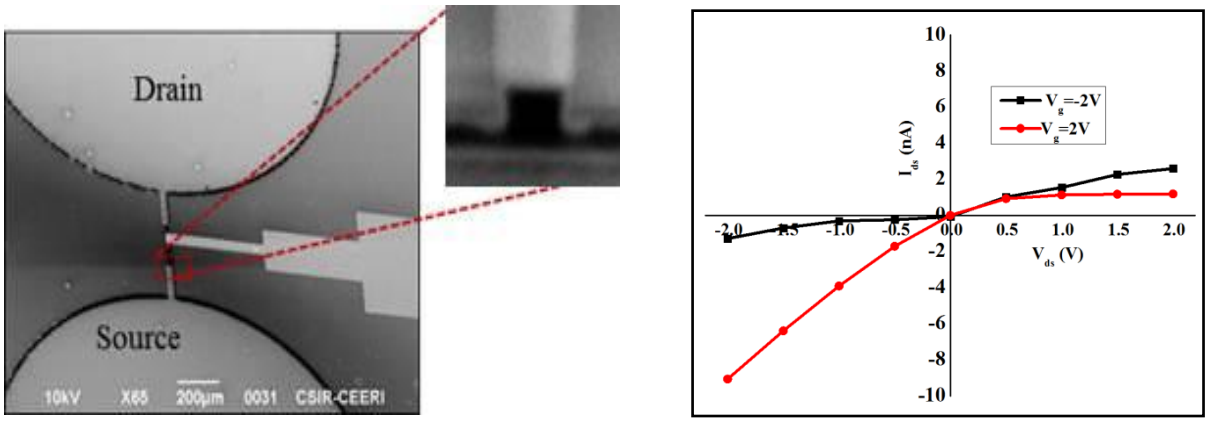
Abstract

Fluidic field effect transistor (Fluid-FET) is referring to an embedded micro/nanofluidic channel with an electrically controllable gate electrode; providing the way to modulate the surface charge property within the channel and leads to control the ionic movement in nanochannels. This work reports an ionic switch named as Fluid-FET, similar to the conventional Field Effect Transistor (FET) with the aim to control the delivery of biological and chemical species in Lab-on-a-chip integrated systems. This device gives much better rectifying degree (better diodic behavior) at very low voltages (<2V) due to very low surface charges without any chemical modification using single gate electrode.

The precise movement of the ions (i.e. K^+, Ca^{2+} etc.) in a preferred direction is demonstrated by asymmetrically positioned external gate electrode. Fluid-FET is realized using standard silicon process techniques with poly-silicon as sacrificial material, allowing thermally grown silicon oxide as capping layer with low surface charges.Various micro-fluidic devices for drug delivery/ discovery applications may need such controlled delivery of ions or drugs.



(a) (b)

Fig. 1(a) SEM Micrograph of Ionic switch (inset shows opening of nanochannels) (b) Current-Voltage curve (I-V) for 1µM $CaCl_2$ concentration showing ionic rectification at V_g=+2 and -2V.