Doping behavior of tetracyanoquinodimethane (TCNQ) and 2,3,5,6-Tetrafluoro-7,7,8,8- tetracyanoquinodimethane (F4-TCNQ) on the MoS_2-FET through microfluidic approach

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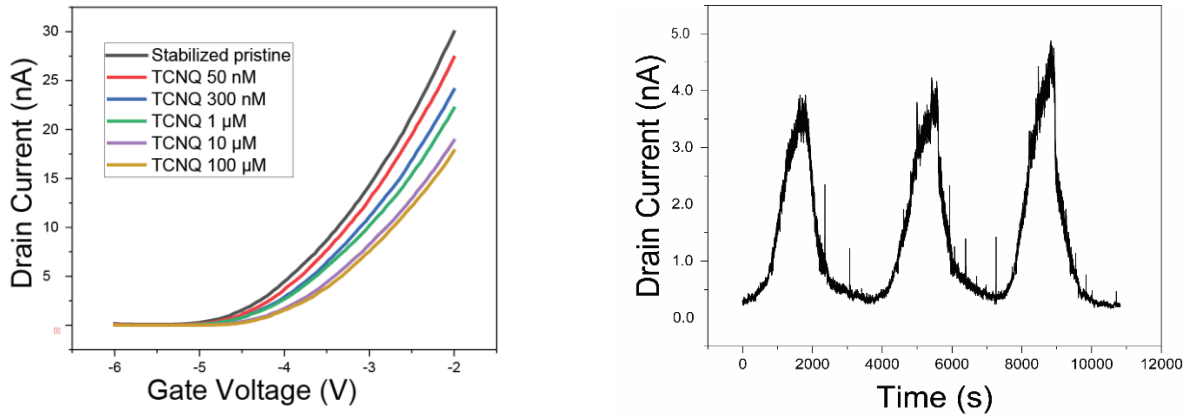
Abstract:

In recent years, molybdenum disulfide (MoS_2), one of the transition metal dichalcogenides (TMDs), is extensively used as an FET channel material[1,2]. In this study, we fabricate a MoS_2-FET device that can detect the change of electrical properties of the FET with a solution flow on the channel. Namely, we prepare a solution of tetracyanoquinodimethane (TCNQ) and 2,3,5,6-tetrafluoro-7,7,8,8-tetracyanoquinodimethane (F4-TCNQ) molecules in isopropyl alcohol (IPA). A fabricated microfluidic tank controls the flow of the solution, and the contact of the solution is restricted in the center of the channel. The threshold voltage (ΔV_{th}) in the Id-Vg plot shifts towards the positive Vg direction for both molecules, indicating acceptor-type doping in the shape of a solution. The shift is proportional to the TCNQ and F4-TCNQ molecular concentrations. The device shows a reversible behavior, and the property returns to the original state when washed by pure IPA solution, and we demonstrate a switching sensor behavior of the fabricated MoS_2. For the switching, the microfluid flow channel contributes to the most accurate sensor behavior detecting the variation of the chemical species. The application of the device for solution chemical recognition will be discussed.



(a) (b)

Figure 1: Drain current for the dry pristine and with changing the concentrations of TCNQ (b) Real-time drain current behavior by alternative change of IPA and 200µM F4-TCNQ

References:

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2) Mak K F, Lee C, Hone J, Shan J and Heinz T F 2010 Phys. Rev. Lett. 105 136805