Tunable Optical Properties of Copper Phthalocyanine Molecules Adsorbed on MoS_2 Based Field Effect Transistor

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In comparison with other transition metal dichalcogenides (TMDs) both single and multilayer molybdenum disulfide (MoS_2) have achieved much popularity for its outstanding electronic and optoelectronic applications. MoS_2 also plays significant role by stacking with organic materials like copper phthalocyanine (CuPc), to use in low power electronics and optoelectronics such as tunneling transistors, photodetectors.

MoS_2 flakes were transferred to 300 nm SiO_2 covered heavily doped silicon substrates using scotch tape method and FET device was fabricated by electron beam lithography. The measurement of electrical properties and CuPc adsorption were performed in a UHV chamber at an operating vacuum pressure (~10^{-6} Pa). Optical properties were observed by injecting light from a monochromatic light source.

The role of CuPc molecules adsorbed on MoS_2 FET under light illumination has been focused on this work. Figure 1 indicates the wavelength(nm)-I_{DS} intensity(A) of pristine and CuPc-MoS_2 FET surface where a new peak is to be found at 720 nm wavelength after light irradiation on CuPc-MoS_2 surface that is absent in pristine MoS_2 FET surface.

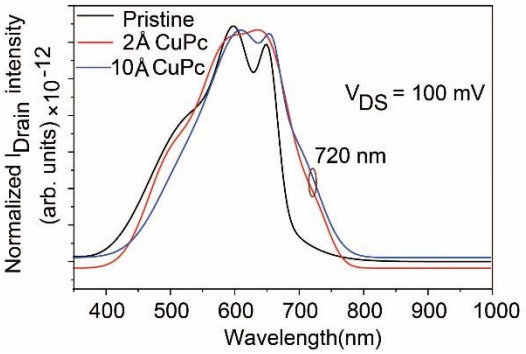

Figure 1: Wavelength-I_{DS} intensity curve of CuPc adsorption on MoS_2 FET under light

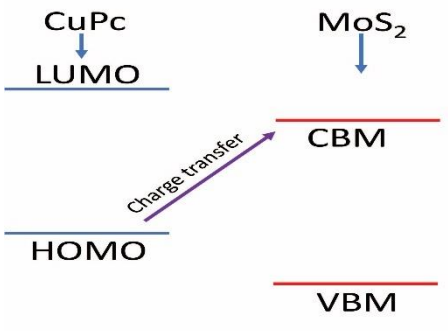

Figure 2: Possible origin of charge transfer transition from the CuPc-MoS_2 interface

The appearance of a new peak suggests that a charge transfer transition happens from the CuPc highest occupied molecular orbital (HOMO) to the MoS_2 conduction band minimum (CBM) that has been demonstrated in Fig. 2.