

Light Induced Electrical Properties of MoS₂ Based Field Effect Transistor with Phthalocyanine Molecule Adsorption

Md Iftekharul Alam¹, Tsuyoshi Takaoka², Hiroki Waizumi¹, M. Shamim Al Mamun¹, Yudai Tanaka¹, Tadahiro Komeda³

Dept. of Chemistry, Tohoku University¹, IMRAM, Tohoku University²

Two-dimensional transition metal dichalcogenides such as MoS₂, one of the transition-metal dichalcogenides, that belongs to the unique physical, optical and electrical properties with high on/off ratio and high mobility correlated with its 2D ultrathin atomic layer structure [1,2]. Phthalocyanines (MPcs) are a promising class of molecules that have been studied extensively as the active material in organic electronics [3].

In this study, we investigated the light induced electrical properties of MoS₂ field effect transistor after phthalocyanine (CoPc, FePc, MnPc, VoPc, CuPc & H₂Pc) molecule adsorption. Figure 1 illustrates the schematic of usual MoS₂ FET device we used in this study. Figure 2 shows the wavelength(nm)-photo current(A) curve of CoPc/MoS₂ surface. The enhancements of the photo current, I_{ph} (A), by CoPc adsorption are ~3, 6.5 and 9.5 times at ~ 660 nm for the thickness of 2, 10 and 20 Å respectively. Other phthalocyanine molecules also exhibited photo enhancement properties with light.

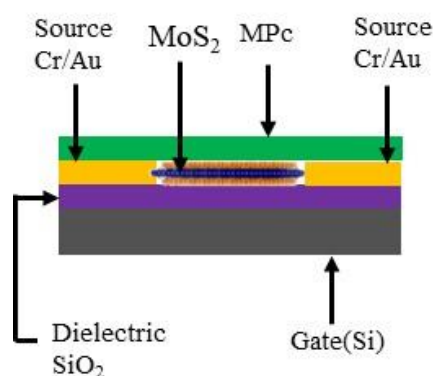


Figure 1: Schematic of MoS₂ FET

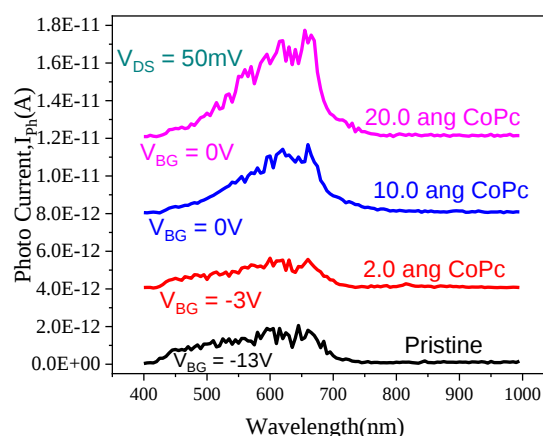


Figure 2: Wavelength-Photo current curve of CoPc adsorption on MoS₂ FET

1. Novoselov, K. S.; Jiang, D.; Schedin, F.; Booth, T. J.; Khotkevich, V. V.; Morozov, S. V.; Geim, A. K. Two-Dimensional Atomic Crystals. *Proc. Natl. Acad. Sci. U.S.A.* 2005, 102, 10451–10453.

2. Splendiani, A.; Sun, L.; Zhang, Y. B.; Li, T. S.; Kim, J.; Chim, C. Y.; Galli, G.; Wang, F. Emerging Photoluminescence in Monolayer MoS₂. *Nano Lett.* 2010, 10, 1271–1275.

3. Nicholas T. Boileau, Rosemary Cranston, Brendan Mirka, Owen A. Melville and Benoit H. Lessard. Metal phthalocyanine organic thin-film transistors: changes in electrical performance and stability in response to temperature and environment. *RSC Adv.*, 2019, 9, 21478.