Kelvin probe force microscopy measurements of graphitic carbon nitrides

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Graphitic (or polymeric) carbon nitrides (g-C_3N_4 and C_3N_5 (Fig. 1(a))) that can be categorized into n-type polymer semiconductors with two-dimensional layered structure, are promising visible-light-responsive materials toward photocatalytic and photoelectrochemical applications. Since many previous studies on their electronic structures and photo-induced charge carrier separation/diffusion have been reported based on macroscopic characterization for bulk (powder) samples, the local charge carrier behaviors therein are largely unexplored and should be investigated for understanding and improving the photocatalytic performance of graphitic carbon nitrides. In this presentation, our Kelvin probe force microscopy (KPFM) measurements of g-C_3N_4 and C_3N_5 under ambient condition will be introduced. An atomic force microscope system (Innova SPM, Bruker AXS) was utilized for topography/surface potential (SP) imaging, where the modulated frequency component of the resulting electric force gradient between the tip and sample was extracted from the phase signal of the cantilever displacement by using a lock-in amplifier.

Molybdenum disulfide (MoS_2)/g-C_3N_4 heterojunction, prepared by transferring exfoliated MoS_2 nanosheets onto a g-C_3N_4 thin film deposited with thermal chemical vapor deposition [1], was examined with KPFM. Upon ultraviolet (UV) illumination, an SP decrease on the MoS_2 side and an SP increase on the g-C_3N_4 side were simultaneously confirmed as shown in Fig. 1(b)~(d), indicating photo-induced charge separation across the MoS_2/g-C_3N_4 interface [2]. Moreover, C_3N_5 nanosheets directly deposited on a Pt electrode showed higher SP values than Pt (Fig. 1(e) and (f)), suggesting Schottky contact formation between C_3N_5 and Pt.

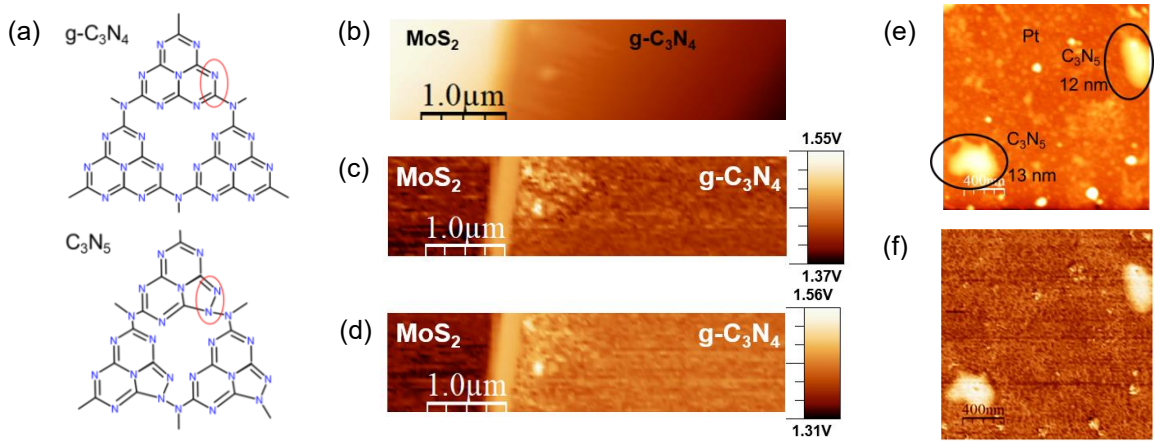

Figure 1. (a) Possible chemical structures of g-C_3N_4 and C_3N_5. (b) Topography and surface potential image (c) under a dark condition and (d) under UV illumination observed on the MoS_2/g-C_3N_4 heterojunction. The thickness of the MoS_2 sheet was 35 nm. (e) Topography and (f) surface potential image of C_3N_5 nanosheets deposited on a Pt electrode observed under a dark condition.

References

[1] K. Ito, Sho Yoneyama, Shu. Yoneyama, P. Fons, K. Noda, ACS Mater. Au **5,** 299 (2025).

[2] Y. Suzuki and K. Noda, poster presentation at NC-AFM2025.