

# Application of nanocarbon and two-dimensional materials to nanoelectronics and sensors

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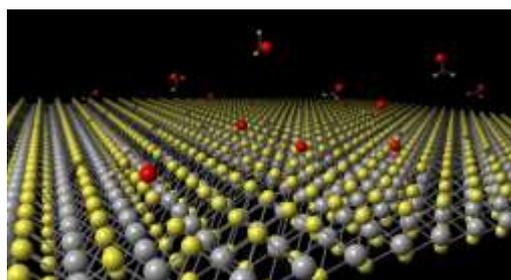
Nanocarbon materials including graphene and carbon nanotubes have excellent electrical properties. In addition, transition metal dichalcogenides exhibit intriguing properties depending on their compositions. These materials are expected to be used for various applications. In fact, we recently demonstrated gas sensors based on graphene-gate transistors [1] and SnS<sub>2</sub> channels (Figure 1) [2]. Each sensor exhibited excellent sensing properties. Actually, HCHO with concentrations down to 1 ppb was detected with SnS<sub>2</sub>-based sensors. We also fabricated interconnect consisting of multilayer graphene grown by chemical vapor deposition (CVD). The interconnect was narrowed down to a width of 8 nm and showed resistivity and reliability better than those of Cu in similar dimensions [3]. We also work on the bottom-up growth of graphene nanoribbons (GNRs) [4, 5, 6], and their application to diodes [7] and transistors (Figure 2) [5]. Our recent progress of the transistor application will be explained in the presentation.

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## References

- [1] N. Harada, et al., IEDM 2016 (2016) 476.
- [2] K. Hayashi, et al., ACS Appl. Mater. Interfaces, DOI: 10.1021/acsami.9b16552.
- [3] D. Kondo et al, IITC2014 (2014) 189.
- [4] H. Hayashi, et al., ACS Nano, 11 (2017) 6204.
- [5] M. Ohtomo, et al., ACS Appl. Mater. Interfaces, 10 (2018) 31623.
- [6] J. Yamaguchi, et al., arXiv:1912.11796.
- [7] N. Harada, et al., Appl. Phys. Express, 10 (2017) 074001.

## Figures



**Figure 1:** Schematic illustration of SnS<sub>2</sub> with HCHO molecules



**Figure 2:** (a) Scanning tunnelling microscope image of nanoribbons used for transistors. (b) Schematic diagram of GNR-transistor device structure. The inset shows the SEM image of the Pd nano-gap.