Annual Meeting of the Japan Society of Vacuum and Surface Science 2021

Challenge of CO oxidation induced by hot carrier on Pd/Si/SiO_2 MOS structure

〇Haobang Yang, Mio Nishida, Aydar Irmikimov, and Ken Hattori*

Nara Institute of Science and Technology

In recent research, there have been some attempts to use semiconductors to control catalytic reactions. Photocatalysts could accelerate chemical reactions using the recombination of excited electrons and holes, however, available energy is restricted in semiconductor band gap energy. To achieve chemical reactions with much higher activation energy, we propose another type of electronic excitation: hot carriers leading to chemical reactions.

This idea has been demonstrated as desorption by hot carriers from a metal-oxide-semiconductor (MOS) structure in electronic circuits. When a gate voltage V_G is applied to the metal electrode in MOS, hot carriers tunnel or ballistically move from the substrate through the insulating thin oxide layer and injected into the surface metal layer, which would induce dissociation, association, and desorption reactions of adsorbed molecules on the metal surface. New functionality based on fabrication techniques has a chance to open up a new semiconductor market for catalytic products.

So far only the desorption process was demonstrated (CO, CO_2 and CH_4 from Si-MOS (Fe/SiO_2/Si) [1]) but not the other processes, such as association for a gas absorbed system inducing chemical reactions. Thus, we are challenging the other dissociation and association processes using a Pd thin film on Si-MOS (Pd/SiO_2/Si) [2], like CO + 1/2 O_2 → CO_2↑ reaction by applying gate voltages. In order to distinguish the introduced gas and residual gas adsorbed on the surface, we dosed isotope $^{18}O_2$ and $C^{16}O$ into the sample surface and confirmed the gas dose system and desorption detection system in V_G applying on Pd-MOS structure. We will report the detailed results in this presentation.

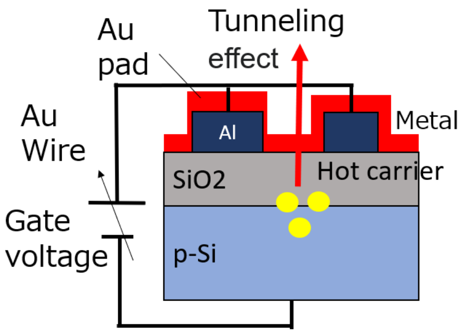

Fig. 1. MOS device structure.

*E-mail: khattori@ms.naist.jp

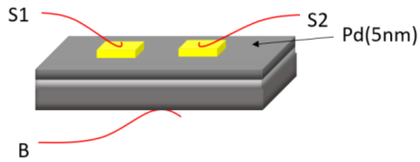

Fig. 2. Pd/Si/SiO2 MOS structure

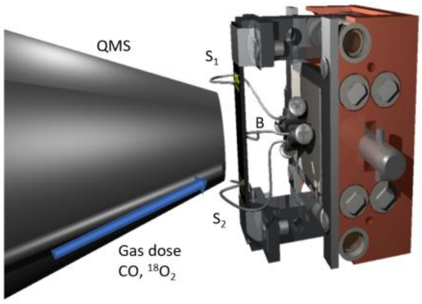

Fig. 3. QMS sensing system.

References

1) N. Hirota, K. Hattori, et al., Appl. Phys. Express 9 (2016) 047002.

2) 楊浩邦, 服部賢ら. 日本物理学会第 76 回年次大会. PSJ-22 (2020).

©The Japan Society of Vacuum and Surface Science