Study the effect of GO: TiO_2 proportions in GO/ TiO_2 composite for the fabrication of QCM Gas Sensor

GSIST, Shizuoka Univ. [a], GSST, Shizuoka Univ. [b], ° P. S. Jayawardena [a], E.K.D.H.D. Siriwardena [b], A. Kubono [a,b] and M. Shimomura [a,b]

E-mail: jayawardena.pramudi.savidya.15@shizuoka.ac.jp

Graphene oxide (GO) contain a range of reactive oxygen functional groups on the sheet surface, which provide a good candidate for supporting metal oxide particles and also may become an ideal sensing platform because of potential hydrogen bonding and π- π stacking interactions [1]. Titania (TiO_2) has been explored for advanced chemical gas sensors based upon different parameters to detect different gas species [2]. This research deals with the construction of sensors based on quartz crystal microbalance (QCM) containing GO / TiO_2 composite sensor layers and to find the optimum composite parameters.

GO was prepared according to the modified Hummers method. TiO_2 was prepared using Ammonium hexafluoro titanate [AHFT]. TiO_2 particles were deposited in aqueous GO solution using liquid phase deposition technique. The composite was spin coated on the gold-plated QCM resonator (5 mm ø, 9 MHz). Appropriate ethanol concentrations were obtained by injecting known volumes of ethanol gas and N_2 gas was passed through the chamber until the frequency difference became stable. All experiments were carried out at room temperature.

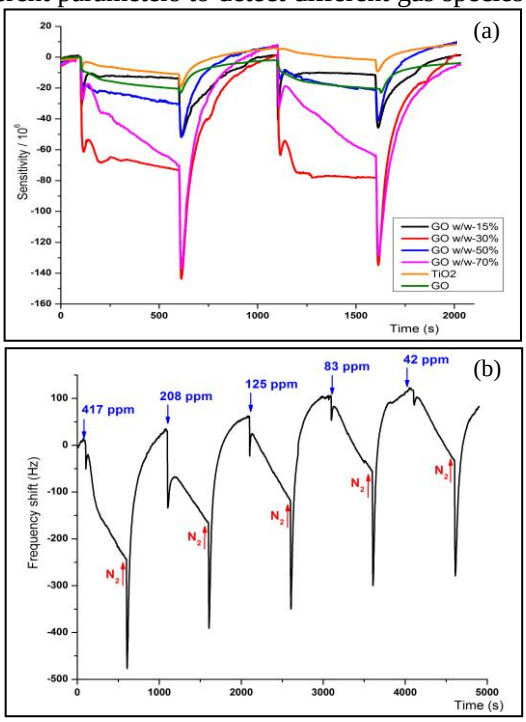

Fig 1. (a) Response to 4167ppm EtOH concentration of the functionalized QCM sensor with GO, TiO_2 and GO/TiO_2 of different GO proportions (b) Plot of frequency shift vs time of GO/TiO_2 (GO w/w=30%) functionalized QCM upon exposure to various low EtOH concentrations

Fig. 1(a) shows the sensor response to 4167ppm EtOH gas of the functionalized QCM sensor with GO, TiO_2 and GO/TiO_2 composite of different GO ratios. Optimum sensitivity was obtained for 30% GO in the precursor solution whereas individual composites show lower sensitivity. Further, sensing performance of functionalized QCM resonator (GO w/w=30%) was examined by changing EtOH concentration from 417 ppm – 42 ppm [Fig. 1(b)]. When EtOH gas was introduced into the testing chamber, all responses obtained were similar in shape and the response of QCM resonator decreased proportionally to the concentrations. This concludes that GO/TiO_2 composite has a significant response to EtOH gas and is anticipated to investigate for other gasses as well.

[1] M. Yang and J. He, Graphene oxide as quartz crystal microbalance sensing layers for detection of formaldehyde, Sens. Actuators B: Chem. 228 (2016) 486–490

[2] M. Procek, A. Stolarczyk, T. Pustelny and E. Maciak, Study of a QCM sensor based on TiO_2 nanostructures for the detection of NO_2 and explosives vapors in air, Sensors.15 (2015) 9563-9581