Pd nanoparticles on poly(amidoamine) dendrimers modified single-walled carbon nanotubes as highly sensitive hydrogen gas sensors

Jun Min Lee[1+], Eunsongyi Lee[1], Kye Jin Jeon[1], Seonghwa Ju[2+] Yeongri Jung[2], Sung-Jin Kim[2] and Wooyoung Lee[1*]*

[1] *Department of Materials Science and Engineering, Yonsei University, 262 Seongsanno Seodaemun-gu, Seoul, 120-749, Korea*

[2] *Division of Nano Science, Ewha Womans University, 11-1 Daehyun-Dong, Seodaemun-Gu, Seoul 120-750, Korea*

Abstract : In order to overcome the lack of reactivity with hydrogen gas (H_2) and utilize unique properties of Carbon Nano Tubes (CNTs) for the application to hydrogen sensors, there have been intensive works on the surface functionalization of CNTs with various types of nanoparticles including Pd.

In the present work, we have investigated the effect of dendrimers and Pd nanoparticles to the hydrogen sensing properties of CNTs by comparing three types of samples: Pd/SWNTs (Sample I), Pd/dendrimer/SWNTs (Sample II) and heat-treated Pd/dendrimers/SWNTs (Sample III). As a result of IV measurement under the H_2 and air, sample I wasfound to have a high sensitivity (25%) to H_2, but to have a very slow response time (324 s) and recovery rate. On the other hand, Sample II was found to show much faster response time (3 s) and good recovery rate but lower sensitivity (8.6%) than Sample I which is due to induced dipole moments in the dendrimers. Interestingly, Sample III showed both fast response time (7 s) and high sensitivity (25%), indicating that the pyrolysis of the dendrimers during heat treatment which reduce the distance between the surface of the SWNTs and the functionalized Pd nanoparticles plays a key role in improving the sensitivity. The pyrolysis of the dendrimers in Pd nanoparticle-dendrimer-SWNTs was found to enable a significant electrical conductance modulation upon exposure to extremely low concentrations (10 ppm) of H_2 in air.

Our results demonstrate that the Pd Nanoparticle-Grafted Single-Walled Carbon Nanotubes(SWNTs) with Dendrimers can be used to detect hydrogen, makingoutstanding properties such as fast response, and recovery time, high sensitivity, low detection limit at room temperature compared with other types of hydrogen sensors.

key words : Single-Walled Carbon Nanotubes(SWNTs),hydrogen sensor, Pd Nanoparticle, surface functionalization, heat treatment, pyrolysis