Mineo Hiramatsu, Int J Mater Sci Res. 2018
http://dx.doi.org/10.18689/2638-1559.a2.002

Synthesis of Vertical Graphene Network

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Graphene is a two-dimensional material with the large anisotropy between in-plane and out-of-plane directions. Graphene-based materials with large surface area are useful as electrodes for electrochemical and bio applications. Carbon nanowalls (CNWs) are layered graphenes with open boundaries, standing vertically on a substrate to form a self-supported network of mazelike-architecture. This kind of carbon nanostructure is also called as carbon nanoflake, carbon nanosheet, graphenenanosheet, and graphenenanowall. CNWs are sometimes decorated with metal nanoparticles and biomolecules. The structure of conductive CNWs with large surface area, combined with surface decoration, would be suitable for the platform in electrochemical and biosensing applications. CNW films can be potentially used as electrodes of electrochemical sensor, capacitor, dye-sensitized solar cell, polymer electrolyte fuel cell (PEFC), and implantable glucose fuel cell (GFC). Among these, CNW electrodes in fuel cells should be decorated with catalytic nanoparticles such as Pt.

CNWs and similar vertical graphene structures can be synthesized by several plasma enhanced chemical vapor deposition (PECVD) techniques on heated substrates (600-800 ˚C) employing methane and hydrogen mixtures. Control of CNW structures including spacing between adjacent nanowalls and crystallinity is significant for the practical applications. Moreover, surface functionalization including surface termination and decoration with catalytic metal nanoparticles should be established. We carried out CNW growth using PECVD employing $CH_4/H_2/Ar$ mixtures with emphasis on the structure control of CNWs. We report the current status of fabrication and structure control of CNWs. Moreover, CNW surface was decorated with Pt nanoparticles by the reduction of chloroplatinic acid or by the metal-organic chemical deposition employing supercritical fluid. We also report the performances of hydrogen peroxide sensor, PEFC and GFC, where CNW electrode was used.

Biography:

Professor Mineo Hiramatsu received his M. Eng. and D. Eng. degrees from Nagoya University. He is a Full Professor of Department of Electrical and Electronic Engineering and the Director of Research Institute, Meijo University, Japan. His main fields of research are plasma diagnostics and plasma processing for the synthesis of thin films and nanostructured materials. Author of more than 150 scientific papers and patents on plasma processes for materials science. Author of 5 books. More than 40 invited speakers at international conferences on plasma science and Nanomaterials. Japan Society of Applied Physics Fellow.