Self-Assembly of Graphene- and Carbon-Nanotubes-Based Structures from Rice Husks using Microwave Plasma Irradiation

◦Zhipeng Wang[1], Hironori Ogata[2], Shingo Morimoto[1], Josue Ortiz-Medina[1], Masatsugu Fujishige[1], Kenji Takeuchi[1], Hiroyuki Muramatsu[1], Takuya Hayashi[1], Mauricio Terrones[1,3], Yoshio Hashimoto[1], Morinobu Endo[1] (1. Shinshu University, 2. Hosei University, 3. The Pennsylvania State University)
E-mail: zp_wang@shinshu-u.ac.jp

Due to theirs huge amount, rice husks (RHs) as waste byproducts of rice consumption pose environmental problems. Previously, RHs have been already employed in some fields of construction materials, fertilizers, animal husbandry rugs, and fuels [1]. However, those applications of the RHs generally focused on some low-added-value processes. There is a huge opportunity to improve the added value of RHs using various scientific and technological methods. Recently, researchers have utilized various techniques and processes to recycle or synthesize pore silicon nanoparticles [2-4] and activated carbon [5-7] from RHs toward high-value applications, such as lithium ion batteries and supercapacitors. More interestingly, Muramatsu et al. utilized the KOH activation of rice husk ash (the combustion of dried RHs in air) to achieve the graphene with nano-size domains and edge-enriched structures, which were confirmed by high-resolution transmission electron microscope [7]. It is well known that graphene, an atomic single layer of hexagonal carbon, has indicated fantastic and excellent physical and chemical properties, and can be regarded as the building block of graphitic carbons including graphite, fullerene, filamentous carbon, carbon nanotubes and graphene nanosheets. Therefore, it is inferred that synthesizing other graphitic carbons from RHs is highly possible by controlling the experiment parameters or means. Unfortunately, up to now, other RH-derived graphitic carbons have never been reported.

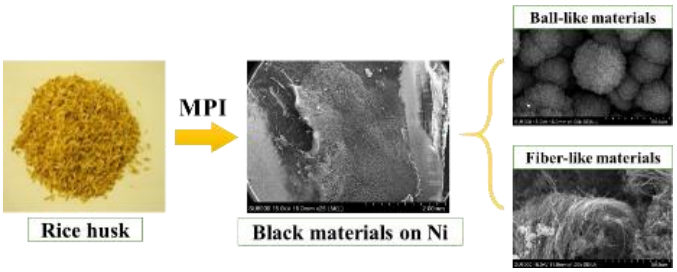

Fig. 1 Fabrication of nanocarbons including graphene- and CNTs-based materials from RHs by MPI technique

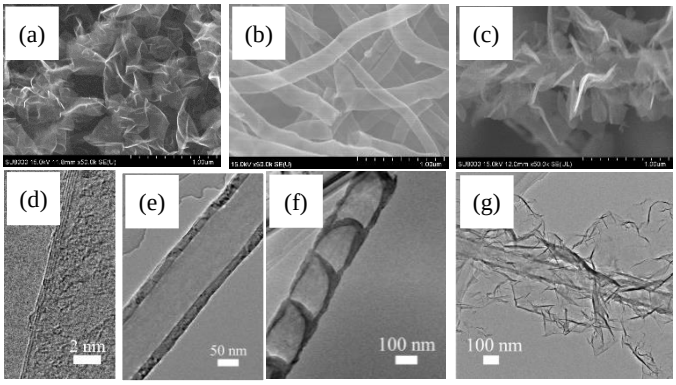

Fig. 2 Scanning electron microscope images of (a) graphene, (b) CNTs, and (c) g-CNTs. Respective transmission electron microscope images of (d) graphene, (e-f) CNTs, and (g) g-CNTs.

In this report, we employ a microwave plasma irradiation (MPI) technique to directly convert RHs into black materials including ball- and fiber-like structures, as shown in Fig. 1. In Fig. 2, these structures consist of graphene, carbon nanotubes (CNTs), and graphenated-CNTs (g-CNTs), which are strongly dependent of the pressure of the reaction chamber. The detailed discussion will be presented in the coming conference.

References

[1] G. Rodrígues de Sensale, Cem. Concr. Compos. ***28***, 158-160 (2006). [2] D.S. Jung, et al. Proc. Natl. Acad. Sci. ***110***, 12229-12234 (2012). [3] N. Liu, et al. Sci. Rep. ***3***, 1-7 (2013). [4] D.P. Wong, et al. J. Mater. Chem. A ***2***, 13437-13441 (2014). [5] P.M. Yelletsky, et al. Micropor. Mesopor. Mat. ***121***, 34-40 (2009). [6] K.L. Van, et al, Prog. Natural Sci.: Mater. ***24***, 191-198 (2014). [7] H. Muramatsu, et al. Small ***10***, 2766-2770 (2014).