SYNTHESIS AND MODIFICATION OF HOLEY GRAPHENE FOR ENERGY STORAGE

Yi Lin,[1] *Jae-Woo Kim*,[1] *John W. Connell*[2]

[1]National Institute of Aerospace, 100 Exploration Way, Hampton, Virginia 23666, [2]Advanced Materials and Processing Branch, NASA Langley Research Center, Hampton, Virginia 23681-2199
Email: yi.lin-1@nasa.gov

Porous graphene materials have recently drawn significant interest for energy storage applications due to the effective use of the graphitic surface area provided by the pores. Holey graphene is a type of porous graphene with pores in the form of physical through thickness holes. This type of porous graphene provides a unique morphology that allows for effective transport of molecular species through the graphene plane. Therefore, as we recently demonstrated, holey graphene could be advantageous in the preparation of electrodes in supercapacitors with high volumetric performance.[1]

We have developed methodologies to scalably prepare holey graphene materials with or without the use of catalysts (Figure 1).[1,2] In this presentation, we will discuss the choice of synthetic strategies and experimental conditions on the morphology and physical properties of holey graphene (Figure 2) and the effect on their electrochemical properties. We will also present the results on the further modification of holey graphene to study their physical and chemical properties, especially with regard to the stability and chemical reactivity of carbons located around the edges of the holes.

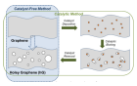

Figure 1. Schematic of the catalytic and catalyst-free processes to synthesize holey graphene.

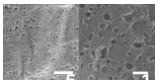

Figure 2. Typical scanning electron microscopy (SEM) images of holey graphene samples prepared from catalyst-free (left) and catalytic (right) processes, the latter of which used silver nanoparticles as the catalysts to create the holes.

References:

(1) Lin, Y.; Kim, J.-W.; Baggett, D. W.; Working, D. W.; Connell, J. W. "Bulk Preparation of Holey Graphene via Controlled Catalytic Oxidation." *Nanoscale* **2013**, *5*, 7814-7824.

(2) Han, X.; Funk, M. R.; Shen, F.; Chen, Y.-C.; Li, Y.; Campbell, C. J.; Dai, J.; Kim, J.-W.; Liao, Y.; Connell, J. W.; Barone, V.; Chen, Z.; Lin, Y.; Hu, L. "Scalable Holey Graphene Synthesis and Dense Electrode Fabrication Toward High Performance Ultracapacitors." *ACS Nano* **2014**, *8*, 8255-8265.