Electrochemistry of Nano-Composites based on Carbon/π-Stacked Supramolecules for Supercapacitors

Shunzo Suematsu, Yumie Nakajima, and Katsuhiko Naoi

Graduate School of Technology,
Tokyo University of Agriculture and Technology
2-24-16 Naka-Cho, Koganei, Tokyo 184-8588, Japan
naoi_lab@cc.tuat.ac.jp
http://www.tuat.ac.jp/~naoi/

In this presentation, we will describe an electroactive supramolecular oligomer coated on nanometer-ordered carbon materials (carbon nano-composites) for next-generation supercapacitor devices. We successfully prepared two kinds of nano-composites, namely, AB/DAAQ and VGCF/DAAQ. These nano-composites consist of acetylene black (AB) and vapor growth carbon fiber (VGCF) coated with the supramolecular 1,5-diaminoanthraquinone (DAAQ) oligomer, respectively. Especially, the VGCF/DAAQ exhibited high specific capacity (200 Ah kg^{-1}) and high charge utilization (*ca.* 80%), as well as excellent redox cyclability (90% of initial specific capacity after the 10,000th cycle).

The AB/DAAQ and VGCF/DAAQ were prepared by ultrasonic chemical polymerization. In order to form the compact and uniform oligomeric DAAQ film onto the AB and VGCF surface, the DAAQ monomers were polymerized in the solutions of well dispersed AB and VGCF (870~2000 nm) under ultrasonic agitation. The average thickness of the oligomeric DAAQ film formed on the AB and VGCF were controllable up to 8 nm.

Several spectroscopic analyses, such as FTIR, UV-vis., and XRD, revealed that the formed oligomeric DAAQ film on VGCF was electroactive and that there is a π-electronic interaction between the surface of VGCF and the attached DAAQ oligomer interfaces (Fig.1), which will lead to enhance the electronic transfer and the interfacial mechanical strength.

As shown in Fig. 2, the obtained specific capacity of the VGCF/DAAQ (200 Ah kg^{-1}) was found to be one order of magnitude higher than those of conventional conducting polymers, such as polypyrrole and polyaniline. Also, the charge utilization (80%) became four times higher than that of the DAAQ oligomer alone (20%).[1] In addition to its high specific capacity and high charge utilization, the redox cyclability for the VGCF/DAAQ was also good (at least, 90% and 75% of initial capacity was maintained even after the 10,000th and 30,000th cycle, respectively).

It is very important to note that the VGCF/DAAQ showed the specific capacity as high as 200 Ah kg^{-1}, the value of which has never attained from the other electroactive organic compounds alone, maintaining its high specific capacity even after the 10^4th cycle.

References

1) S. Suematsu and K. Naoi, *J. Power Sources,* **97-98,** 816 (2001).

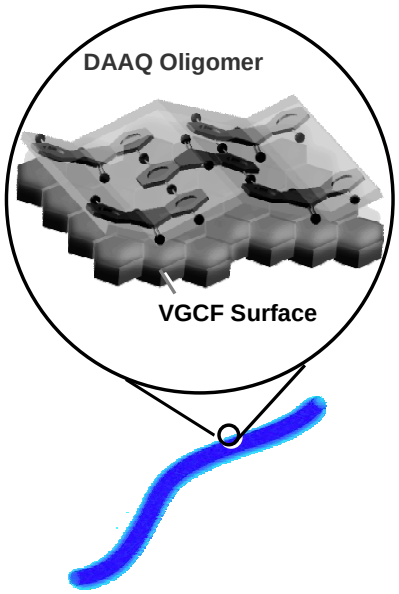

Fig. 1 Schematic illustration for a π-electronic interaction between the surface of VGCF and the attached DAAQ interface.

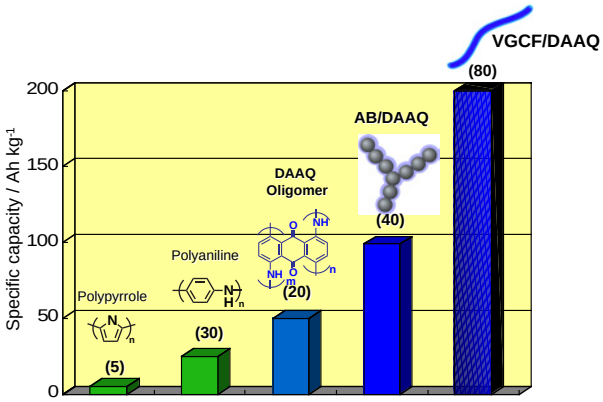

Fig. 2 Values of specific capacity and charge utilization (numbers in brackets) for the conventional conducting polymers, DAAQ oligomer, AB/DAAQ, and VGCF/DAAQ. Each value of specific capacity was calculated from the obtained capacity divided by weight of redox-active material.