CHAPTER 5:
NEW NANO- THROUGH MACRO-CARBONS
FOR ENERGY SYSTEMS: SYNTHESIS,
MODELING, CHARACTERIZATION
Chapter 5: Subject Overview

A collection of six papers in this chapter addresses subjects of synthesis, characterization and modeling of new promising carbon materials, which have not yet found application in the market of power sources, but may do so in the foreseeable future.

Thus, in the first paper on stabilization mechanisms discovered for reaction of synthesis of graphite nitrate, M. Savoskin et al. uncovers a number of valuable, unknown phenomena related to production of expandable graphite (GIC), an intermediate product in manufacturing of thermally exfoliated graphite. The later carbon type is currently being used in many battery systems as one of the most efficient conductive additives for electrode matrixes. Authors study intercalation of graphite via reaction of flake with nitric acid, followed by additions of a modifier. An attempt is made in the paper to group various (mostly organic) modifiers into classes. Extensive experimental data is presented in order to support the suggested mechanism of formation of stable GICs.

The paper by Kovalenko et al. introduces a method of cyclic voltammetry as a way to estimate stability of various carbon materials towards electrochemical oxidation. This reaction is of particular significance in rechargeable batteries with aqueous electrolytes. Authors discuss results of the electrochemical performance of expanded graphite, whose surface/structure has been modified by 5wt% B2O3. Reportedly, this graphite outperforms conventional graphite in terms of featuring higher resistance towards electrochemical corrosion.

Dimovski et al. addresses a very interesting concept of synthesis of various forms of carbon materials through reaction of chlorine treatment of iron carbides, typically found in the kish graphite ore. Currently, kish is a worthless compound, found in tailings of metallurgical plants. Recovering graphite from it could be a very beneficial idea. The authors were able to synthesize amorphous carbon structures at temperatures of chlorine below 1000°C, while at higher temperatures some well-graphitized synthetic graphite has been recovered. If commercialized, the technology may have revolutionary implications, also for the needs of energy market.

The contribution by Rouzaud et al. teaches to apply a modified version of high resolution Transmission Electron Microscopy (TEM) as an efficient technique of quantitative investigation of the mechanism of irreversible capacity loss in various carbon candidates for application in lithium-ion batteries. The authors introduce the “Corridor model”, which is interesting and is likely to stimulate active discussion within the lithium-ion battery community. Besides carbon fibers coated with polycarbon (a candidate anode material for lithium-ion technology), authors study carbon aerogels, a known material for supercapacitor application. Besides the capability to form an efficient double electric layer in these aerogels, authors
report observing some hydrogen storage capability with this type of carbon materials. Reportedly, about 1% of hydrogen can be stored and released by the micropores of an aerogel synthesized at 2600°C.

The fifth paper in this chapter is by S. Kochetova and N. Tumanova of the National Academy of Sciences of Ukraine. It addresses subjects of electrolysis of molten carbamides. Authors report on interesting results of their study of the mechanisms of reactions occurring in the carbamide and carbamide-chloride melts using techniques of cyclic voltammetry in combination with gas chromatography and IR spectroscopy.

In the last paper of this chapter, the authors M. Savoskin, M. Mochalin et al. of L. M. Livinenko Institute of Physical Organic and Coal Chemistry in Donetsk, Ukraine introduce simple methods of “one-step” synthesis of carbon-carbon composites, as well as relatively new to the world, carbon structures called “nanoscrolls”. The authors use graphite intercalation compounds as precursors. Editors like to specifically draw the reader’s attention to the open-ended carbon nanostructures shown by Figure 4 in the subject paper. While being unable to qualify the yield of these unusual nano-compounds, authors suggest the open-ended materials could be used for storage of various foreign molecules, one of them being hydrogen.

Editors hope that readers will find this chapter interesting and educating.