MECHANICAL ACTIVATION AND MECHANOCHEMICAL REACTIONS: FUNDAMENTALS AND APPLICATION FOR LITHIUM-ION BATTERIES

Nina V. Kosova
Institute of Solid State Chemistry and Mechanochemistry, Siberian Branch of the Russian Academy of Sciences, 18 Kutateladze, Novosibirsk 630128, Russia

E-mail: kosova@solid.nsc.ru

Recently, many methods for preparing materials for lithium-ion batteries have been explored. High-energy solid-state mechanical activation (MA) is one of the modern and promising synthetic methods to prepare different nanostructured functional materials [1]. This is due to the potential application of mechanochemical reactions in technology, in particular, for the development of so-called dry processes, which are more environmentally friendly and cost-efficient than the currently adopted technologies. MA provides better contacts between the reagents as a result of mixing, decreasing particle size, generating fresh surface for the contacts, and also by inducing melting and sublimation of reagents. MA affects solid-state reactions by improving diffusion, generating strain, structural, electronic and ionic defects, as well as by creating pulses of pressure and temperature. A peculiar feature of mechanochemical reactions is that the products can be formed in a metastable state, similar to what happens during fast crystallization, when there is no time for an equilibrium structure to be formed. This can bring to novel materials with new structures and new electrochemical properties. When MA is combined with other techniques, its advantages can be more fully displayed.

To optimize the process, the choosing of the appropriate reagents for the fast-propagating mechanochemical reactions is important. In this study, different mechanochemical reactions were used to prepare nanostructured electrode materials for lithium-ion batteries, including acid-base reactions, redox reactions, association reactions, ‘core’-‘shell’ and composite materials formation [2-4].

[1] E. Avvakumov, M. Senna, N. Kosova, Soft Mechanochemical Synthesis: A Basis for New Chemical Technologies, Kluwer Acad. Publ., 2001.
[2] N.V. Kosova, In: High-energy ball milling: Mechanochemical processing of nanopowders, Ed. M. Sopicka-Lizer, Woodhead Publ., 2010.
[3] N.V. Kosova, E.T. Devyatkina, Russ. J. Electrochem. 48 (2012) 320-329.
[4] N.V. Kosova, E.T. Devyatkina, Doklady Chemistry 458 (2014) 194-197.