

унит-М с привитыми группами CONH₂. Наличие провала при концентрации 0.4% подтверждает механизмы, описанные в моделях [1,2], показывая переход от дисперсного армирования к волокнистому. Отсутствие провала в данных работы [3] вызвано, по-видимому, большим шагом изменения концентрации УНТ.

Зависимость прочностных свойств композита от концентрации ф-УНТ.

| Концентрация УНТ, % | Прочность на разрыв, нормировано на контрольный образец |
|---------------------|---|
| 0 | 1 |
| 0.2 | 1.23 |
| 0.3 | 1.61 |
| 0.4 | 1.07 |
| 0.5 | 1.78 |
| 0.6 | 1.65 |

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QUANTITATIVE CHARACTERIZATION OF THE IONIC MOBILITY AND CONCENTRATION IN LI-BATTERY CATHODES VIA LOW FREQUENCY ELECTROCHEMICAL STRAIN MICROSCOPY

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Modernization of power sources occurs today together with fast technological progress. One of the conditions for the power sources development is an increasing of the batteries and accumulators consumer characteristics. This task is an impossible without understanding of the local processes, occurring in the material during interca-

lation and deintercalation. Scanning probe microscopy (SPM) is successfully used for investigation of the local ionic mobility in the electrode materials through the several methods. One of the favorite method without complicated realization scheme is an electrochemical strain microscopy (ESM), where the local surface displacement appeared as result of external electric field application is analyzed by the lock-in amplifier technique. Displacement arises due to the changing of the lattice parameters with the ion concentration variation under the SPM tip (Vegard effect). The ESM spectroscopy approach based on the application of the AC and DC voltage to the SPM tip is usually qualitative due to complexity of process occurred during DC voltage application: electrostatic and electrostrictive tip-surface interaction, undesirable chemical reactions and phase transitions [1].

Here we introduce novel artefact-free quantitative approach for the determination of diffusion coefficients and ion concentration estimation with nanoscale resolution based on the ESM signal frequency dependence [2]. We considered theoretically in the system with ion blocking and electron non-blocking electrodes the evolution of ionic concentration profiles and derived the equation for the frequency dependence. The experimental curves measured by ESM spectroscopy in low frequency range (10-100 kHz) was found to be good approximated by theoretical equation and values of local diffusion coefficient $2.2 \times 10^{-9} \text{ cm}^2 \text{ s}^{-1}$ were closed to macroscopic values $\sim 10^{-9} \text{ cm}^2 \text{ s}^{-1}$ [3].

The diffusion coefficient and the ion concentration distribution revealed an existence of the three regions inside the LiMn_2O_4 particles: the interface region with a lower diffusion coefficient, the area with a maximal Li ion concentration close to the grain boundary interface and the interior of the grain depleted with Li ions (Fig. 1).

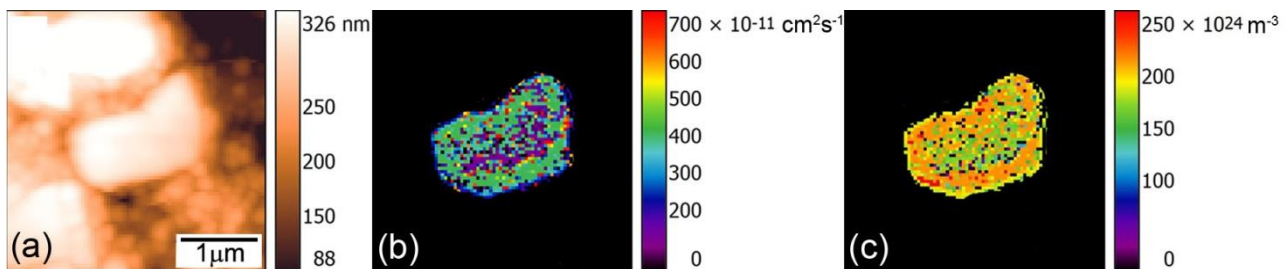


Fig. 1. Maps of the diffusion coefficient (b) and the ion concentration (c) along with the topography (a) in ionically active particles of LiMn_2O_4 cathodes.

The work was financially supported by Russian Science Foundation (Grant 17-72-10144). The equipment of the Ural Center for Shared Use “Modern nanotechnology” UrFU was used.

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