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**IMPACT OF MECHANICAL TREATMENT DURATION ON THE
NANOPOWDER COMPOSITES BASED ON THE TRANSITION AND
SEMIMETALS OXIDES**

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It is well known that the electrochemical properties of nanosized materials depend on their structural and morphological features, electronic structure, development and surface defects, etc. Different methods of synthesis and processing are used to improve such features. One of the most promising methods is mechanical treatment using vibration mill (microbreaker) [1, 2]. In this paper, I want to briefly describe the effect of the duration of such machining of a mixture of nano-sized oxides 80 % SiO₂/20 % Al₂O₃ and 80 % SiO₂/20 % TiO₂ on the structure and electrochemical properties of lithium batteries.

First of all, I would like to draw attention to the fact that the vibration treatment was carried out at constant processing parameters, namely the oscillation frequency of the reactor was 50 Hz, the reactor with a diameter of 25 mm using one metal ball with a diameter of 10 mm [1]. Mechanical processing was carried out under the same conditions, but for 3, 5, 10, 15 and 20 minutes [3-5]. The morphology of the nanoparticles before and after MBT was studied using scanning electron microscopy (SEM) on PEM-106 equipment. The crystalline structure of the nanocomposites was studied using the Ultima IV diffractometer (XRD). The electronic structure was investigated using ultra-soft X-ray emission spectroscopy (USXES) on RSM-500 spectrometer. Electrochemical characteristics were investigated at the TIONiT P2.00 booth in galvanostatic and potentiodynamic modes.

From the results of SEM and XRD, it was found that in both composites, with a processing duration of up to 5 min, fragmentation of the initial agglomerates is observed without a significant change in the coherent scattering region [3, 5]. With longer processing (10-20 minutes), there is a rapid agglomeration of nanocomposites and an increase in coherent scattering field, which is most likely the result of layering particles on top of each other. It should be noted that there are no significant changes in the

parameters of the crystal lattice of materials after all processing durations. In addition, from the results of USXES (Fig.1 *a*), a general trend of decreasing the charge state of oxygen as a result of an increase in the duration of machining was established [5]. However, it should be noted that after nanopowder treatment during 3 min, there is a slight decrease in the integrated intensity of the $OK\alpha$ -spectra that is most likely the result of the adsorbed water evaporation from the mixture [4, 5]. Mechano-synthesis processing during 5 min is accompanied by a rapid increase in the integral intensity of the $OK\alpha$ -spectra in the energy range corresponding to the π -states of oxygen. This may indicate the formation of π -bonds between the surface atoms of the nanocomposite particles as a result of treatment for 5 min [3]. An increase in the processing duration up to 10-20 min is accompanied by a decrease in the population of electrons in the Op_{π} -energy range, which indicates a rupture of the π -bonds formed during the first 5 min [5]. Comparing the results of galvanostatic cycling (Fig.1 *b*) with the results of USXES (Fig.1 *a*), a clear relationship can be seen between the change in the electronic structure and capacity/power of lithium batteries with increasing machining duration. Namely, the tendency to decrease the battery capacity by increasing the processing duration of the nanocomposite (Fig.1 *b*). However, the largest battery capacity falls on the original nanocomposite, which is associated with the presence of adsorbed water in the mesopores of the composite, which leads to an increase in capacity due to oxidation/reduction reactions. However, this water prevents further cycling of the battery because it forms a stable lithium oxide film on the surface of the nanocomposite [4, 5]. On the other hand, the high capacity of the battery, with a mixture-based cathode after 5 min of treatment (Fig.1 *b*), is a consequence of the formation of a high charge state of oxygen (Fig.1 *a*), which is the result of the formation of π -bonds between the surface particles of both oxides. This charge makes it possible to form a higher battery charge due to oxidation/reduction reactions, but without the formation of a stable sedimentary film on the surface of the cathode material, this leads to the fact that such batteries are better cycled. This result is well supported by the results of potentiodynamic studies of the obtained nanocomposites [4, 5]. Based on the above, it can be confidently stated that increasing the charge state due to the formation of π -bonds between composite

nanoparticles during machining is an effective and cheap method of increasing the electrochemical characteristics of lithium batteries.

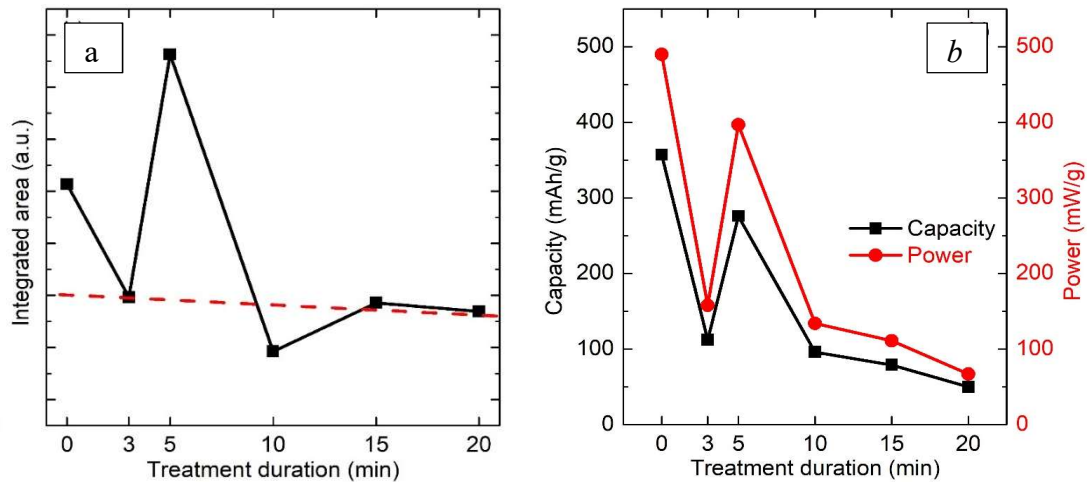


Fig. 1. Impact of treatment duration on charge state and electrochemical characteristics of 80 % SiO₂/20 % TiO₂ [5]: *a* – dependence of the integrated area of OK_α-spectra on the mechanosynthesis treatment duration, *b* – discharge dependence of the capacity and power of lithium power source on the treatment duration

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**BIOCOMPATIBLE Zr-Ti-Nb ALLOY FOR MEDICAL IMPLANTS:
CHARACTERIZATION OF PROPERTIES AND COMPARISON WITH
Ti-6Al-4V**

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Study presents an investigation of a novel biocompatible Zr-Ti-Nb alloy developed for medical implant applications. The study encompasses analysis of the alloy's chemical composition, structural, physical, and mechanical properties, alongside a comparative evaluation against the conventional titanium alloy Ti-6Al-4V. The Zr-Ti-Nb alloy demonstrates a low elastic modulus (26.4 GPa), closely matching that of cortical bone, superior plasticity, satisfactory corrosion resistance, and absence of toxic elements, making it a promising candidate for implantology.

Over the past several decades, significant attention within the scientific community has been directed towards the development of biocompatible implant materials that combine high strength, corrosion resistance, and minimal toxicity. Titanium alloys,