SOFIA ELECTROCHEMICAL DAYS '2019

October 16-19, 2019, Sofia, BULGARIA

BOOK OF ABSTRACTS

Dedicated to the 150th Annyversary of the Bulgarian Academy of Sciences

18 October 2019	9:00	**Petra Uhlmann:** Functional nanostructured thin films for energy applications	Technical Exhibition
	9:30	**Vesna Miskovic-Stankovic:** Graphene-based Poly(vinyl alcohol)/Chitosan Hydrogels with Electrochemically Synthesized Silver Nanoparticles for Medical Applications	
	10:00	**Balamurugan Devadas:** Electrochemical generation of hypervalent iodine derivatives as metal free organic oxidants	
	10:40-11:10	*Coffee Break*	
		YOUNG SCIENTISTS' SESSION	
	11:10	**Lyubomir Soserov:** Electrochemical characteristics of poly-phase nickel-manganese composites electrodes for hybrid supercapacitors	
	11:30	**Denis Paskalev:** NET-Tools-a different approach to education and training on Hydrogen and Fuel Cell Technology	
	11.50	**Elitsa Chorbadzhiyska:** Biocatalyzed electrolysis for hydrogen production	
	12:10	**Iveta Boshnakova:** Montmorillonite supported tin/iridium as anode catalyst for PEM water electrolysis	
	12:30	**Ivo Bardarov:** Environmental monitoring platform powered by Sediment Microbial Fuel Cells	
	12:50	**Ognyan Dimitrov:** PEG modified ZrO_2 sol-gel films: Morphological features and optical properties	
	13:00-14:30	*Lunch*	Technical Exhibition
	14:30	**George Pchelarov:** Application of electrocatalysts based on different carbon forms	
	14:50	**Miglena Slavova:** Influence of the catalyst on the electrochemical behavior of zeolite based gas-diffusion electrode: In Memory of Zdravko Stoynov	
	15:10	**Svetlana Veleva:** The potential of sodium titanate as an electrode material in hybrid electrochemical systems	
	15:30	**Laurent Arurault:** Green anodization and innovative sealings to protect aeronautical aluminum alloys against corrosion	
	16:00	**Award Ceremony & Closing Remarks**	
	19:00	**CONFERENCE DINNER**	
19 October 2019	9:00 -	**Excursion**	

POSTER SESSION I (Wednesday, 16th of October 2019)

PI_01	**B. Abrashev**, T. Spassov, L. Myhailov, St. Todorova, K. Petrov AB_5 alloys as anode material for metal hydride (MH) air battery application
PI_02	**I. Popov**, K. Banov, T. Petkov, B. Mladenova, R. Boukoureshtlieva, B.Banov Silver porphyrin as a catalyst for Oxygen Reduction Reaction in Metal-air systems with water electrolyte
PI_03	**M. Alakushev**, K. Ignatova Electrodeposition and properties of Ni-Co-P alloy coatings and powders for lithium-ion batteries
PI_04	D. Pavlov†, V. Naidenov, **Y. Milusheva,** S. Vassilev, T. Shibahara, M. Tozuka Effect of benzyl benzoate added to the electrolyte on the sulfation processes in lead-acid batteries
PI_05	**G. Ivanova,** A. Stoyanova, B. Aladjov, V. Petrova, P. Lilov, O. Petkov, A. Stoyanova- Ivanova Optimization of zinc active mass for Ni-Zn battery
PI_06	**B. Karamanova**, A. Stoyanova, R. Stoyanova, M. Georgiev A study of the electrochemical behaviour of symmetric supercapacitors based on carbon biomaterials in organic electrolytes
PI_07	V.Vitkova, G. Popkirov, **A. Stoyanova-Ivanova**, V. Petrova, O. Petkov Electrochemical impedance spectroscopy of lipid bilayers
PI_08	**M. Gabrovska**, D. Nikolova, E. Mladenova, G. Rajkova, D. Vladikova, Z. Stoynov† Ni/Co_3O_4 composite electrode for application in metal air batteries
PI_09	**K. Banov**, B. Mladenova, I. Popov, T. Petkov, B. Banov Electrochemical characteristics of AEM prepared by different methods
PI_10	**K. Banov**, I.Popov, T. Petkov, B. Banov Preparation and electrochemical evaluation of modified manganese oxides
PI_11	**M. Kalapsazova**, E. Zhecheva, R.Stoyanova Effect of Mg content in P3-type $Na_{2/3}Ni_{1/2-x}Mg_xMn_{1/2}O_2$ ($0 \le x \le 1/6$) as a high-performance cathode material for hybrid Na-Li cells
PI_12	**T. Boyadzhieva**, V. Koleva, R. Stoyanova Fe-containing Phospho-olivines as Electrodes in Hybrid Metal-Ion Batteries
PI_13	**A. Aleksandrova**, M. Matrakova, P. Nikolov, M. Markova–Velichkova, D. Kovacheva A Study of Different Crystallite Size Zno Additive on The Performance of Lead-Acid Battery Negative Electrodes
PI_14	**V. Milusheva,** B. Tzaneva, M. Petrova Electroless Copper Deposition on Anodized Aluminum
PI_15	**G. Ilieva**, D. Ivanova, L. Fachikov Characterization of thin phosphate films on aluminum surfaces obtained electrochemically
PI_16	**V. Chakarova**, M. Georgieva, D. Lazarova, M. Petrova, E. Dobreva Chemical Deposition of Thin Nickel Coatings on ABS Dielectrics
PI_17	F. Caubert, P. Louis Taberna, **L. Arurault**, B. Fori Electrophoretic deposition of boehmite particles to improve the anti-corrosion behaviour of anodized aluminium alloys 1050 and 2024-T3
PI_18	**E.Petkucheva**, G.Borisov, E.Lefterova, E.Slavcheva Photoelectrochemical water splitting by MoS3/FeSe-photocathodes

Electrochemical Characteristics of Polyphase Nickel-Manganese Composites Electrodes for Hybrid Supercapacitors

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Hybrid supercapacitors were proposed as an opportunity to increase the limited energy density of conventional carbon electrical double layer capacitors (EDLCs). These systems combine the advantages of long lifetime and high cycling rates of activated carbon negative electrodes together with those of Faradaic positive electrodes in aqueous electrolytes.

In the last few years nanostructured transition metal oxides/hydroxides as a new type of energy storage materials have widely attracted attention. In our previous research, we appear that layered $Na_{0.5}Ni_{0.5}Mn_{0.5}O_2$-derived composites are suitable for application as electrode materials in hybrid supercapacitors. But due to its low surface area, this composite shows low capacitance [1].

The present work is focused on the electrochemical performances of hybrid supercapacitors based on synthesized mixed nickel- manganese oxides/hydroxides in the form of structured and polyphase composites with high specific surface area. $Ni_{0.5}Mn_{0.5}OH$, $Ni_{0.5}Mn_{0.5}(OH)_2$ (dried) and $Ni_{0.5}Mn_{0.5}O_3$, $Ni_{0.5}Mn_{0.5}O_x$ (by chemical decomposition at 400°C) have been investigated in a mixed alkaline electrolyte (7M KOH with 1.45M LiOH).

The structure, morphology and porous texture properties of composites are analyzed by means of powder X-ray diffraction (XRD), scanning electron microscopy (SEM) and low-temperature nitrogen adsorption, respectively. The electrochemical performances of composites electrodes are determined by galvanostatic charge/discharge and long-term tests. The *ex-situ* XRD and SEM are used to monitor the changes in composite electrodes during the electrochemical cell function.

The electrochemical test results confirm our previous assumption that the presence of two or three compounds with high specific surface area in the composite electrode leads to the formation of structures suitable for application in hybrid supercapacitors and to reach a higher capacitance values.

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References:

[1] L. Soserov, A. Stoyanova, T. Boyadzhieva, V. Koleva, M. Kalapsazova, R. Stoyanova, Electrochim. Acta 283 (2018) 1063.

The Potential of Sodium Titanate as an Electrode Material in Hybrid Electrochemical Systems

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The energy storage mechanisms of electrode materials for both Na- and Li-ion systems can largely be generalized into either insertion, fast Faradaic, alloying, or conversion-based processes. Intercalation materials possess the ability to accommodate ions within their structures via n-dimensional channels [1].

Titanate-based materials are considered as attractive electrode materials for Na-ion batteries due to the low cost and high natural abundance of titania, good thermal stability and a preference for forming layered structures with suitably wide crystal lattice spacing, which favours insertion processes [2].

The present study provides new data on the electrochemical performance of nanotube sodium titanate as an electrochemically active material for hybrid systems including sodium-ion batteries and supercapacitors.

The sodium titanate with nanotube morphology is synthesized hydrothermally using NaOH and TiO_2. The structure and morphology of titanates were determined be means of modern physicochemical methods. To go inside into surface and bulk electrode changes during electrode cycling, the *ex-situ* XPS and SEM/EDS study were undertaken.

The electrochemical performances of nanotube Na-titanate are examined in half ion cells and in a hybrid supercapacitor cell and subjected to charge-discharge cycling test at different current rates. The half-cell test were performed versus metallic Li anode with various organic electrolytes: 0.5 M $Mg(TFSI)_2$, 0.5 M $Li(TFSI)_2$, $LiPF_6$, $NaPF_6$, and $LiBF_4$. It is found that this material is able to co-intercalate reversibly Mg^{2+} , Li^+ and Na^+ ions at potential lower than 1.5 V versus Li/Li^+. The hybrid supercapacitors with composite electrode, containing Na-titanate and positive activated carbon electrode (commercial YP-50F, "Kuraray Europe" GmbH) in $LiBF_4$-electrolyte are developed. All results indicate that nanotube sodium titanate is a promising material for hybrid energy systems.

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References

[1] Q. Ni, Y. Bai, F. Wu, C. Wu, Adv. Sci., 4 (2017) Article 1600275

[2] L. Wu, D. Buchholz, D. Bresser, L. Chagas, S. Passerini, J. Power Sources 251 (2014) 379-385

A Study of the Electrochemical Behaviour of Symmetric Supercapacitors Based on Carbon Biomaterials in Organic Electrolytes

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Supercapacitor, an upgrade version of the capacitor, can be successfully performed with large amounts of power for efficiency enhancement as energy storage technologies. The properties of supercapacitors come from the interaction of their internal materials. Especially, the combination of electrode material and type of electrolyte determine the functionality and thermal and electrical characteristics of the capacitors.

Supercapacitors can operate in a "voltage window" with a specified upper and lower voltage limit. Voltages outside the window can cause electrolyte decomposition damaging the device. The maximum operating voltage of the EC largely depends on the electrochemical stability of the electrolyte, which in turn determines its energy density and power. Capacitor electrolytes may be aqueous or non-aqueous. The aqueous electrolytes are generally safer and easier to use, but they are limited up to 1 V due to water decomposition at 1.23 V, while the voltage on the supercapacitor cells based on organic electrolytes, including ionic liquids can reach up to 3.6 V, even higher.

The present study provides data on the optimal potential working limits on symmetric supercapacitor based on biogenic activated carbon (YP-50F, “Kuraray Europe” GmbH) in three types of organic electrolytes-$LiBF_4$, $LiPF_6$ and $NaPF_6$ (with different solvents). For this purpose the assembled cells were electrochemically examined using cyclic voltammetry in different voltage windows (from 0,8 to 4 V) and different scan rates (from 1 to 100 mVs^{-1}). It is found, that in $NaPF_6$- electrolyte the supercapacitor can work in most widely potential limits. Galvanostatic charge/discharge and long-term tests within the identified potential limits are in progress.

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