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### ALUMINA MATRIX CERAMIC NIKEL COMPOSITES FORMED BY CENTRIFUGAL SLIP CASTING

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The paper is focused on the possibility of the fabricating the alumina matrix ceramic-nickel composites with gradient concentration of metal particles. As the method of composite fabrication, centrifugal slip casting was chosen. This method allows to fabricate the graded distribution of nickel particles in the hollow cylinder composites. The horizontal rotation axis was applied.

In the experiments the following powders were used:  $\alpha$ -Al<sub>2</sub>O<sub>3</sub> TM-DAR from Taimei Chemicals (Japan) of an average particle size 133 nm and density 3.96 g/cm<sup>3</sup>, Ni powder from Sigma-Aldrich of an average particle size 3  $\mu$ m and density 8.9 g/cm<sup>3</sup>. Aqueous based slurries (with 50 vol.% content of solid phase) containing alumina and nickel powder (10 vol.%) were tested. A composition of deflocculates i.e. diammonium citrate (p.a., Aldrich) and citric acid (p.a., POCH Gliwice) were used. Final sintering was conducted on all the specimens at 1400 °C in reducing atmosphere (N<sub>2</sub>/H<sub>2</sub>).

The obtained samples were characterized by X-ray diffraction studies (XRD), scanning electron microscopy (SEM) and energy dispersive X-ray analysis (EDS). Quantitative description of the microstructure of the composites was made on the basis of SEM images using computer image analysis.

The macroscopic as well SEM observations of composites confirmed the gradient concentration of Ni particles in the composites material. Application of the centrifugal slip casting method allows for the graded distribution of metal particles in the samples.

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### DEVELOPMENT OF CORE-SHELL STRUCTURED METAL OXIDE POWDERS TO BE USED AS LITHIUM ION BATTERY CATHODE MATERIALS

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Lithium Manganese Oxide (LiMn<sub>2</sub>O<sub>4</sub>, LMO) (4.1 V, 148 mAh/g) and Lithium Nickel Manganese Oxide (Li<sub>2</sub>NiMn<sub>3</sub>O<sub>8</sub>, LMNO) (4.7 V, 148 mAh/g) are high voltage

cathode materials aiming at high energy density battery applications like electric vehicles [1]. However, their applicability in actual devices is limited due to their low electrochemical stability with most of the commercial electrolytes at high potentials. The purpose of this research is to introduce a core-shell structure for the battery cathode using LM(N)O as the core and TiO<sub>2</sub> as the shell material to prevent the electrolyte decomposition on the surface of the LM(N)O particles. A kinetics controlled coating technique [2] mainly based on hydrolysis and condensation reactions of titanium butoxide (TBOT) was used to initiate heterogenous nucleation and growth of TiO<sub>2</sub> on commercial LM(N)O particles in an ethanol based environment. The effect of different synthesis parameters; such as the LM(N)O amount, the TBOT amount and the reaction time on the shell formation was examined using scanning electron microscopy (SEM) and energy-dispersive X-ray spectroscopy (EDS). SEM images revealed changes in surface morphology when compared to the bare, commercial LMO powders. Titanium and oxygen signals revealed by EDS also pointed out possible formation of a thin TiO<sub>2</sub> layer on LMO particles. However, powder agglomeration was observed via SEM after coating process. To avoid agglomeration, studies were focused on increasing the zeta-potential value of the core particles by surface functionalization. Citric acid functionalized [3] LMNO particles revealed stable dispersions at a pH of 10 with a zeta-potential value of about -54 mV in aqueous medium while the non-functionalized LMNO particles revealed about -16 mV at the same pH. Effect of using the citric acid functionalized starting powders in the ethanol based actual shell synthesis medium is further to be investigated.

### References

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### **CERAMIC COMPOSITES BASED ON TiO<sub>2</sub> NANOTUBES FOR APPLICATION IN SOLAR CELLS**

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Application of ceramic materials is restricted due to their low fracture toughness. One of the ways to increase the mechanical properties of ceramics is insertion of metallic ductile phase, creating ceramic/metal composites. One group of such materials are functional gradient materials (FGM) which some properties (such as hardness) change as a function of distance from the surface of the material.