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PREFACE

The author gives thanks to Allah for bestowing His blessing and direction, allowing the **Metalurgi Journal Volume 39, Edition 2**, **2024** to be successfully published.

The first article results from Sri Mulyati Latifa and colleagues' research activities on the *Synthesis of Mesoporous Nickel using Electrodeposition Method*. Agsel Fauzia Hakim and colleagues presented the second article, *Study of Iron and Calcium Removal on Manganese Sulfate Precursors for Battery Cathode Raw Material Applications*. Fionna Angellinnov and colleagues investigated the *Optimization of NMC811 Synthesis via Oxalate Coprecipitation Method for Lithium-ion Battery Cathodein* the following article. For the fourth article, Fakhrudin Yudomustafa and colleagues studied *Study on Leaching Lanthanum from Ferronickel Slag with Pretreatment Alkaline Fusion*. The fifth article by Kurotun Aini and her colleagues discussed a *The Effect of Single and Double-Doped Addition on 8YSZ Coating Layers Deposited on Inconel 625 by Electrophoretic Deposition*.

The publication of this volume in the Metalurgi Journal will benefit the advancement of research in Indonesia.

EDITORIAL

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Synthesis of Mesoporous Nickel using Electrodeposition Method

Mesoporous material technology has recently become increasingly popular among scientists and industry professionals. Electrodeposition is a metal deposition process that employs an electric current. The most typical applications of electrodeposition are metal coating (electroplating) and the creation of porous materials. This study aimed to analyze the effects of current and nickel synthesis time on the formation of mesoporous nickel morphology using corn starch. The method for producing mesoporous nickel deposits uses an electrodeposition process using corn starch additives. The process of making mesoporous nickel varies at currents of 4, 5, and 6 A, holding times of 3, 4, and 5 hours, and additional weights of corn starch of 1, 2, and 3 g, with the weight of nickel deposits produced being 1.19, 1.3, and 1.9 g, with an increase in nickel deposits from currents of 4 to 6 A (holding time of 3 to 5 hours) of 0.71 g (59.66%). The smallest pore diameter of 112 nm was obtained using a current of 6 A, a holding time of 5 hours, with 3 g of corn starch. Characterization was carried out on the electrodeposition layer using XRD (x-ray diffraction) and SEM-EDS (scanning electron microscope-energy dispersive spectroscopy), where the results of the XRD analysis showed the presence of α-Ni, Ɣ-Fe, and Fe_1Ni_3 compounds, and the results of SEM-EDS showed porous Ni deposits with the highest Ni concentration above 80%. The bigger the current employed and the holding period in the electrodeposition process, the heavier the Ni deposit formed

Keywords: Mesoporous, electrodeposition, nickel, α*-Ni,* Fe_1Ni_3 *compounds*

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Agsel Fauzia Hakim[a], Lia Andriyah[b], Soesaptri Oediyani[a], Latifa Hanum Lalasari[b], Eko Sulistiyono[b], Januar Irawan[b], Tri Arini[b], Fariza Eka Yunita[b], Ariyo Suharyanto[b], Iwan Setiawan[b], Florentinus Firdiyono[b], Akhmad Herman Yuwono[c,d] ([a]Department of Metallurgy, Sultan Ageng Tirtayasa University; [b]Research Center for Metallurgy, National Research and Innovation Agency (BRIN) ; [c]Department of Metallurgical and Materials Engineering, University of Indonesia; [d]Advanced Materials Research Center, University of Indonesia)

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Study of Iron and Calcium Removal on Manganese Sulfate Precursors for Battery Cathode Raw Material Applications

Global battery sales are expected to reach $310.8 billion in 2027, up 14.1% from 2020. 95% of the world's batteries are lead-acid, lithium-ion, or nickel-based. One of the most popular batteries on the global market is lithium-ion, which uses MnSO4 powder as its cathode raw material. Manganese sulfate-based lithium-ion batteries can be made using Indonesian resources, specifically manganese ore from Trenggalek. Trenggalek manganese ore is of poor quality and contains impurities, primarily Fe and Ca. To produce 98% powder manganese sulfate, the solution is prepared, reduced with briquette charcoal, leached, precipitated, carbonated, and crystallised. NH_4OH reagent is used to remove Fe through precipitation, and the carbonatation process is employed to eliminate Ca, resulting in 97.237% purity of manganese sulfate powder product. This outcome is achieved under precipitation process conditions of [NH_4OH 2M], T = 80 °C, pH = 4, t =180 minutes, while carbonatation process conditions are T=50 °C, t = 120 minutes.

Keywords: Lithium-ion batteries, iron recipitation, carbonatation, manganese sulphate

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Fiona Angellinnov[a], Achmad Subhan[b], Bambang Priyono[a,c], and Anne Zulfia Syahrial[a,c] ([a]Department of Metallurgical and Materials Engineering, University of Indonesia; [b]Research Center for Advanced Materials, National Research and Innovation Agency (BRIN); [c]Tropical Renewable Energy Centre, University of Indonesia)

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Optimization of NMC811 Synthesis via Oxalate Coprecipitation Method for Lithium-Ion Battery Cathode

NMC811 was synthesized through the oxalate coprecipitation method, followed by the solid-state method of lithiation. ***.*** *Stirring speed (500, 750, 1000 rpm), aging time (0, 3, 5 h), sintering atmosphere (with and without oxygen flow), sintering temperature (700, 750, 800 °C), and lithium concentration (0, 2, 5% excess) effect on the NMC811 were examined. Characterization results showed that the optimum stirring speed and aging time are 750 rpm and 3 hours. Based on structural analysis, the best condition for sintering is in oxygen atmospheres at 800 °C with a lithium concentration of 2% excess. NMC811, synthesized with these optimum parameters, provided a 212.93 mAh/g capacity. These findings deliver insight into NMC811 synthesis optimization.*

Keywords: Cathode material, oxalate coprecipitation, NMC811, synthesis method

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Fakhruddin Yudomustafa[1], Eni Febriana[2], Wahyu Mayangsari[2], Nurhayati Indah Ciptasari[2], Ari Yustisia Akbar[2], Hendrik[2], Soesaptri Oediyani[1] and Agus Budi Prasetyo[2] ([1]Department of Metallurgy, Sultan Ageng Tirtayasa University; [2]Research Center for Metallurgy, National Research and Innovation Agency (BRIN))

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Study on Leaching Lanthanum from Ferronickel Slag with Pretreatment Alkali Fusion

Ferronickel slag is a byproduct of nickel ore smelting. Several efforts have been made to find alternative applications for ferronickel slag, such as the production of construction materials, cement, or geopolymers. It is reported that 38% is used for road construction, 48% is used for industrial cement mixtures, and the rest is used for fertilizers, geopolymers, and hydraulic techniques. Ferronickel slag still contains some valuable minerals such as silica, magnesium, nickel, iron, and several REEs (rare earth elements). One of the REEs, namely lanthanum, has many applications, including Ni-MH (nickel-metal hydride) batteries, phosphors for lamps, fluid-cracking catalysts for oil refining, LaNi5 for hydrogen gas storage, metal alloys for cast iron, steel and magnesium alloys, additives for glassware (for cameras), and lanthanum hexaboride ceramic. In connection with the slag, which contains impurities in strong silica compounds, it is necessary to carry out an alkaline fusion treatment. Alkaline fusion was carried out by varying the time from 0.5 to 4 hours and the ratio of the mass of slag to NaOH: 1:0.6, 1:1, 1:1.23, 1:1.47, and 1:1.84. The biggest decrease in SiO_2 was in the 3-hour alkaline fusion time, from 48.347% to 27.3%, and in the mass ratio at 1:1.47, from 48.347% to 21.413%. This research aims to provide added value for ferronickel slag by extracting lanthanum by acid leaching using H_2SO_4 reagent by varying the time (5, 10, 30, 60, and 120 minutes), temperature (30, 60, and 90 °C), and concentration (1, 2, and 3 M). The results showed that the best leaching point was at 5 minutes, 30 °C, and 1 M, yielding a lanthanum extraction percentage of 38.082%.

Keywords: Acid leaching, added value, alkali fusion, ferronickel slag, lanthanum

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UDC (OXDCF)

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The Effect of Single and Double-Doped Addition on 8YSZ Coating Layers Deposited on Inconel 625 by Electrophoretic Deposition

The ceramic layers of 8 mol% yttria-stabilized zirconia (8YSZ), singly doped with Fe2O3 and doubly doped with Fe2O3 and Al2O3, have been deposited successfully on Inconel 625 substrates by the EPD (electrophoretic deposition) process. The oxide doping influenced the stability of the EPD suspension and affected the density of the resultant layer. To improve the adhesion between the layer and the substrate, a two-step sintering was performed up to 1200 ºC for a total duration of 4 hours in a horizontal vacuum furnace, with a heating rate of 2 ºC per minute in an Argon gas atmosphere. FE-SEM (field emission scanning electron microscopy) and vickers hardness tests were employed to investigate the effect of single and double doping on the morphology and hardness of the coating layers, respectively. EDS (energy dispersive spectroscopy) was employed to analyze the elemental composition of the layers, while XRD (x-ray diffractometry) was utilized to determine the crystalline phases. The results indicated that the double-doped coating sample possesses a better microstructure, and the layer with double doping exhibits a denser microstructure and reduced porosity (3.84%) in contrast to the single-doping layer (6.05%). The vickers hardness test indicates a rise in hardness from 65.3 HV with single doping to 283.78 HV with double-doping layers, due to the presence of Al2O3 as the interstitial agent, which reduces the layer's porosity and enhances adhesion between the layer and the substrate. Furthermore, the addition of Al¬2O3 as the double dopant may impede the t□ m phase transformation, leading to enhanced thermal stability in the double-doped coating sample compared to the single-doped coating sample. This study shows that double-doping techniques can improve the efficiency of ceramic coatings for high-temperature applications, such as gas turbine components, and also gives opportunities for more research in oxidation, corrosion, and erosion testing.

Keywords: Al_2O_3*, electrophoretic deposition,* Fe_2O_3*, inconel 625, yttrium-stabilized zirconia*