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PREFACE

Thanks to Allah SWT, the Metalurgi Journal, Volume 37 Number 3, December 2022, could present six articles.

Miftakhur Rohmah and colleagues conducted research on the Effect of Nickel Addition and Quench-Temper Process on Mechanical and Corrosion Properties of ASTM A588 Weathering Steel. The second paper, Anodizing-Electrodeposition Hybrid Coating by Using Synthesized Natrium Silicate and Zirconium Oxide on the Surface Magnesium AZ31B, was presented by Aprilia Erryani and colleagues. Aptri Mira and colleagues presented Morphology and Resistivity Values of Fluorine-Doped Tin Oxide (FTO) Using Local Dimethyl Tin Dichloride (DMTC) Precursors from Indonesia. Mochamad Afriansyah Zunaidi and his colleagues discussed The Iron Removal Process from Nickel Pregnant Leach Solution Using Sodium Hydroxide in the fourth article. Gyan Prameswara and his colleagues talked about Optimizing the Laterite Ore Grinding Process with A Ball Mill Using the Response Surface Method. Resetiana Dwi Desiati and colleagues discussed the Structure, Mechanical Properties, and Oxidation Resistance of Mn-Rich Fe-Mn-Al Alloys in their six article.

The publication of this volume in the Metalurgi Journal should, hopefully, help to advance research in Indonesia.

EDITORIAL

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UDC (OXDCF) 553.4

Miftakhur Rohmah[a], Gilang Ramadhan[b], Dedi Irawan[a], Dedi Pria Utama[a], Toni Bambang Romijarso[a] ([a] Research Center for Metallurgy, National Research and Innovation Agency, [b] Departments of Metallurgical and Materials Engineering, Institut Teknologi Kalimantan)

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Effect of Nickel Addition and Quench-Temper Process on Mechanical and Corrosion Properties of ASTM A588 Weathering Steel

Mechanical improvement and "self-protection" properties are mainly needed to develop weather-resistant steel materials. In this study, A588 steel was given thermomechanical treatment (hot-rolling) followed by a quenching-tempering process. The A588 steel is modified by adding 1, 2, and 3 wt.% nickel to the primary alloy. Steel is made using a hot rolling process at 1050 °C for 1 hour with 70% thickness reduction. The sample is heat-treated at 850 °C temperature for 1 hour and quenched in water, oil, and open air. The tempering process is conducted at 400 °C for 30 minutes. The metallography test confirmed the final microstructural and compared it with CCT (continuous cooling transformation) by Jmatpro simulation result. The fast cooling (water and oil quenchant) followed by the tempering process produces tempered martensite, ferrite, and pearlite, while the air-cooled forms a ferrite-pearlite. The cooling rate significantly affects strength and hardness and the nickel addition on hardness, and both factors have no significant on ductility. The sample owns the highest tensile strength value (~1226 MPa) with 1 %Ni, and the highest ductility value (around 17.1–27.43%) is obtained by air cooling. With 3% Ni, the corrosion rate decreases to 0.072 MPY with -432.5 mV for corrosion potential and 0.12µA/cm^{-2} for current density.

Keywords: A588, tempered martensite, cooling medium, nickel addition, quench-temper

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Aprilia Erryani[a], Bunga Rani Elvira[a], Syifa Ranggayoni Nurbaiti[b], Amalia Syahiddah[b], Hafsah Mujahidah[b], Yudi NugrahaThaha[a], Esmar Budi[b] ([a]Research Center for Metallurgy National Research and Innovation Agency, [b]Fisika, Universitas Negeri Jakarta)

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Anodizing-Electrodeposition Hybrid Coating by Using Synthesized Natrium Silicate and Zirconium Oxide on The Surface Magnesium AZ31B

In this study, sodium silicate was synthesized, and zirconia was characterized as a suspension solution for anodization and electrodeposition processes. The results of the FTIR (fourier transform infrared) synthesis demonstrated the success of producing Na_2SiO_3 with the appearance of absorption from functional groups such as silanol (Si-OH) and siloxane (Si-O-Si) According to the SEM (scanning electron microscope) data, each batch contains oxygen, sodium, and silicon, indicating that Na_2SiO_3 was successfully synthesized without any detectable impurities. SEM images revealed that the calcination of $ZrOCl_2.8H_2O$ was dominated by zircon elements, with batch 3 having the highest zircon content at 88.81%. The XRD (x-ray diffraction) results show that ZrO_2 (monoclinic) dominates, with Cl_2 present in batches 1 and 3. As a result, the ZrO_2 used without calcination is in batch 3. Anodizing and electrodeposition processes can be performed in three ways: a. anodizing, b. two steps (anodizing-electrodeposition), and c. one step hybrid (anodizing and electrodeposition) with the addition of Al_2O_3 and $Na_2O_7SiO_3$ elements to the electrolyte. After coating, the surface of magnesium appears to be a pale white line. SEM images revealed that all three methods are coated and contain elements such as O, Na, Mg, Zr, Si, K, and Al in method c. The three samples also revealed that the sanding process was not optimal and that the Zr particles on the surface were not evenly distributed.

Keywords: Anodizing, electrodeposition, ZrO_2, sodium silicate, magnesium

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Aptri Mira Rizki[1], Fariza Eka Yunita[2], Latifa Hanum Lalasari[2], Januar Irawan[2], Tri Arini[2], F.Firdiyono[2], Akhmad Herman Yuwono[4], Lia Andriyah[2], Nadia Chrisayu Natasha[2] ([1]Department of Chemistry, Sebelas Maret University (UNS), [2]Research Center for Metallurgy, National Research and Innovation Agency, Department of Metallurgical and Materials Engineering, Universitas Indonesia)

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Morphology and Resistivity Values of Fluorine-Doped Tin Oxide (FTO) Using Indonesian Local Dimethyl Tin Dichloride (DMTC) Precursors

TCO (transparent conductive oxide) is the main component for solar cell fabrication. One of the promising types of TCO is FTO (fluorine-doped tin oxide). The method used in depositing the conductive layer of FTO is spray pyrolysis with an ultrasonic nebulizer. The precursor used is a local Indonesian product, DMTC (dimethyltin dichloride) with doping ammonium fluoride (NH_4F). The variable that used in this study were variations in deposition time (5, 10, 15, 20, and 25 minutes) with a fixed substrate temperature at 300 °C and doping variations (un-doped, 2 wt.% doped, and 8 wt.% doped) to see the effect of adding F doping to the precursor solution. The resistivity values with a variation of deposition time 5, 10, 15, 20, and 25 minutes (2 wt.% doped) are $0.218x10^{0}$; $0.449x10^{-1}$; $1,567x10^{-2}$; $0.676x10^{-2}$ $0.377x10^{-2}$ Ω.cm. For doping variations (un-doped, 2 wt.% doped, and 8 wt.% doped) the values are $0.883x10^{-2}$; $0.377x10^{-2}$; $0.506x10^{-3}$ Ω.cm. The resistivity values tend to decrease with an increase in deposition time and doping addition, resulting in enhanced conductivity. The grain size will increase as deposition time and doping are both increased. In this study, the optimal resistivity value of $0.377x10^{-2}$.cm was obtained at a deposition time of 25 minutes with 2 wt.% doping.

Keywords: FTO (fluorine-doped tin oxide), DMTC (dimethyltin dichloride), deposition time, doping, resistivity

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Mochamad Afriansyah Zunaidi[a], Iwan Setiawan[b], Soesaptri Oediyani[a], Januar Irawan[b], Ahmad Rizky Rhamdani[b], Adi Noer Syahid[b] ([a]Metallurgical Engineering, Faculty of Engineering, University of Sultan Ageng Tirtayasa, [b]Research Center for Metallurgy, National Research and Innovation Agency)

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Iron Removal Process from Nickel Pregnant Leach Solution Using Sodium Hydroxide

Indonesia is a country that has abundant mineral resources, including nickel resources in laterite ore. Nickel demand has risen significantly because of the need for nickel precursors for battery production. Nickel laterite can be processed via the hydrometallurgical route to obtain nickel precursor by leaching the laterite ore with an acid solution to produce a nickel-rich solution or PLS (pregnant leach solutions). This nickel-rich solution is then precipitated with a base solution to produce MHP hydroxides (mixed hydroxides precipitate). MHP is the primary product containing nickel and cobalt for the production of lithium battery material. PLS often contains iron impurities, which dissolve when the ore is leached. As a result, the iron must be separated in order to produce high-purity MHP. To address this issue, synthetic PLS with nickel, cobalt, and iron were created, and their concentration was simulated to match the general PLS composition. The experiment revealed that iron could be precipitated in two stages using 2.5 M NaOH solution at solution pH of 3 and 3.5. At a higher pH, nickel and cobalt can be precipitated. To investigate the effect of pH and temperature on the yield of nickel and cobalt precipitation, precipitation was carried out at pH 7, 8, and 9 and temperatures of 70, 80, and 90 °C. The results show that the highest yield was obtained at a pH of 9 and a temperature of 90 °C, with nickel and cobalt precipitation yields of 99.03% and 98.78%, respectively.

Keywords: MHP (mixed hydroxide precipitate), iron removal, pH, temperature, precipitate

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Gyan Prameswara, Flaviana Yohanala Prista Tyassena, Idi Amin, Husnul Hatimah (Mineral Chemical Engineering, Makassar ATI Polytechnic)

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Optimization of Laterite Ore Grinding Process Using Ball Mill with Response Surface Method

This study used a CCD (central composite design) of RSM to determine the dependence and interaction between several operating conditions that affect the grinding process using a ball mill, such as the number of balls, grinding duration, and rotational speed, on particle size at 80% product mass (P80) and mineral liberation (response surface method). The grinding process was carried out in a cylindrical ball mill with a diameter and length of 18.6 cm and 21.5 cm, respectively, as well as a steel ball with a diameter of 2.5 cm and a weight of 100 grams/ball. A sieve aperture of 180-600 microns is used to analyze the particle size distribution. The optimum data for the grinding process was obtained with the smallest response value of P_{80} *(513.294 µm). It was known that the number of balls and grinding duration significantly affected the reduction of the* P_{80} *value in the sample. The model that can describe the influence of process variables on the* P_{80} *value was obtained with good accuracy. The elemental concentration and the XRD (x-ray diffraction) pattern were used to determine the mineral content of the sample. Minerals with a lower hardness scale are more easily liberated and exposed. The initial material's* P_{80} *value was 1560.89 µm, while the P80 grinding process was reduced to 513.29 µm under optimal conditions.*

Keywords: CCD (central composite design), grinding, RSM (response surface method), laterite, nickel

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Resetiana Dwi Desiati, Edi Sutiawan, Toto Sudiro, Bambang Hermanto (Research Center for Advanced Materials, National Research and Innovation Agency)

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Structure, Mechanical Properties, and Oxidation Resistance of Mn-Rich Fe-Mn-Al Alloys

In this study, Mn-rich Fe-Mn-Al alloys with different Al content (Al = 0, 3, and 5 wt.%) were fabricated from ferromanganese lumps using a conventional powder metallurgy technique. The samples were compacted in 1 cm steel dies using a load of 8 tons and then sintered at 1100 ℃ for 2 h in a tubular furnace under a vacuum condition of around 0.5 mbar. To evaluate the effect of Al addition to Fe-Mn-Al alloy, the Archimedes principle and Vickers hardness were applied to estimate the density and hardness of the compact alloys. Moreover, the high-temperature oxidation resistance of the alloy was evaluated at 800 ℃ for 8 cycles. The structure of the alloy before and after oxidation was studied using XRD (x-ray diffractometer) and SEM-EDS (scanning electron microscope-energy dispersive spectrometry). The XRD analysis results show that the FeMn-0Al alloy is mainly composed Fe_3Mn_7 phase, with the presence of FeAl phase at 3 wt.% Al, and Al_8Mn_5 phase at 5 wt.% Al. The density and hardness of Fe-Mn-Al alloys decreased with the increased Al content. Fe-Mn-Al alloy without Al addition exhibits poor oxidation resistance since the first cycle of the test. The results of the microstructural analysis showed that although the alloy with the addition of 3 wt.% Al showed less mass gain after being exposed for 8 cycles at 800 ℃, the Fe-Mn-Al alloy with 5 wt.% tended to be more resistant to oxidation and had no cracking defects. The structure of the oxide formed on the surface of the alloy is composed of two layers (ie; outer and inner layer) which are affected by each alloy composition.

Keywords: Fe-Mn-Al alloy, conventional powder metallurgy, density, hardness, oxidation