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PREFACE

Thanks to Allah SWT, because of the help of Allah Metalurgi Magazine, Volume 37 Number 1, April 2022, could present five articles.

The first article results from Tiya Khairina Izzati and colleagues' research activities on The Effect of Heat Treatment and Surface Anodization on Wear and Friction Coefficient of 2024 Aluminum Using Pin-on-Disk Method. Syahwira Taqwa Triadi presented the second article, Dynamic Plastic Deformation Induced by Repetitive Hammering on Cr-Mn Austenitic Stainless Steel. Moch Syaiful Anwar and his colleagues presented Grain Growth Kinetics of Austenitic Stainless Steel 316L and the Relations between Grain Sizes and Hardness under Isothermal Conditions in the following article. For the fourth article, Eko Sulistiyono and his colleagues discussed the Effectiveness of Magnesium and Lithium Separation from Seawater Using a Sodium Silicate Precipitation Process. The fifth article, written by Eka Fitri Wulandari and colleagues, discussed The Effect of Voltage and Time in the Synthesis of Manganese Dioxide from Manganese Sulfate Precursor.

Hopefully, the publication of this volume of Metalurgi Magazine will benefit the advancement of research in Indonesia.

EDITORIAL

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UDC (OXDCF) 621.402

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Metalurgi, Vol. 37 No. 1 April 2022

The Effect of Heat Treatment and Surface Anodication on Wear and Friction Coefficient of 2024 Aluminum Using Pin-on-disk Method

The use of aluminum alloys as a material for engineering components that rub against each other is increasing, so it is important to know the friction characteristics of these aluminum alloys. In this study, 2024 aluminum was given heat treatment with variations in aging time or an anodization process. Then, the wear and friction coefficient tests were carried out using a pin tool on the disc. The effect of aging time and surface anodization on wear tests are carried out to determine the amount of wear, and the coefficient of friction test is carried out to determine the coefficient of friction of the material when it rubs against a pin made of AISI 52100 steel. The coefficient of friction test is carried out by adding lubrication type as a parameter. The test results showed that the aluminum alloy given heat treatment had better resistance than that not heat treated. This is because the heat treatment creates precipitates that can increase aluminum's hardness and wear resistance. Whereas for anodized aluminum alloy, the alumina layer can act as an abrasive grain when continuously given a high enough friction and load. Hence the wear testing mode changes from dry sliding wear to three-body abrasive wear and decreased wear resistance. From the friction coefficient test results, the aging time affects the hardness of the aluminum alloy, which leads to the value of the coefficient of friction. The harder the aluminum alloy surface, the smaller the coefficient of friction obtained. Furthermore, applying lubricant to the aluminum alloy will also decrease the value of the friction coefficient of the alloy. Lubricating oil will provide a more significant reduction in friction coefficient than air. Finally, the anodizing surface on the aluminum alloy will act as a lubricant reservoir when it occurs.

Keywords: 2024 Aluminum, wear resistance, coefficient of friction, pin-on-disk test

METALURGI

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Metalurgi, Vol. 37 No. 1 April 2022

Dynamic Plastic Deformation Induced by Repetitive Hammering on Cr-Mn Austenitic Stainless Steel

Austenitic stainless steels have advantages, such as high ductility and good corrosion resistance. The cold working process can increase the hardness and strength of the material. However, because a metastable austenite phase occurs in that material, there is a phase change of γ austenite to α'-martensite and ε-martensite, which will reduce the ductility and its corrosion resistance. The strengthening process with DPD (dynamic plastic deformation) can prevent the formation of martensitic phases through repeated impact at high strain rates. This study analyzed microstructures and hardness evaluation on Cr-Mn austenitic stainless steel due to dynamic plastic deformation through the repetitive hammering method. Repetitive hammering with a strain rate of 6,2 s^{-1} on Cr-Mn austenitic stainless steels was carried out on five specimens with variations in the impact of 50, 100, 150, 250, and 350 times with impact energy of 486 J/cm^2; 2.207 J/cm^2; 2.569 J/cm^2; 6.070 J/cm^2; and 11.330 J/cm^2 respectively. Microstructure, hardness, and XRD (x-ray diffraction) analyses were carried out on Cr-Mn austenitic stainless steels before and after repetitive hammering. Metallography was carried out to observe the microstructure using an optical microscope. The hardness was tested through the Rockwell A hardness test. XRD examination was used to identify the phases formed and indications of nano-twins. The repetitive hammering process up to 350 times has succeeded in increasing hardness from 53.5 HRA to 71.6 HRA. Plastic deformation introduced by repetitive hammering produced slip bands, cross bands, wavy bands, and an indication of nano-twins formation and increased hardness.

*Keywords: DPD (dynamic plastic deformation), repetitive hammering, nano-twins, Cr-Mn austenitic stainless steel, SFE (stacking fault energy)***)**

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Grain Growth Kinetics of Austenitic Stainless Steel 316L and the Relations Between Grain Sizes and Hardness under Isothermal Conditions

The 316L austenitic stainless steel is usually used in nuclear power plant. This steel has an austenitic phase at room temperature, and it can change grain size after being exposed at high temperatures. This study aims to investigate grain growth behavior and hardness of 316L austenitic stainless steel after cold-rolled and annealing to 1100 °C with holding times of 0, 900, 1800, 2700, 3600 s. The result showed that the grain growth of 316L austenitic stainless steel usually occurs. Austenite grain size of 316L increased with increasing holding time, resulting in hardness decreases. Experimental grain growth of 316L austenitic stainless steel shows no significant difference from the prediction, with an error of about 0.7. The highest Micro Vickers hardness is found at a grain size of 14.93 µm.

Keywords: Austenitic stainless steel 316L, grain growth kinetics, hardness, modeling

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Metalurgi, Vol. 37 No. 1 April 2022

Effectiveness of the Separation of Magnesium and Lithium from Seawater with Sodium Silicate Precipitation Process

The purpose of this experiment was to separate magnesium ions and lithium ions from seawater in order to obtain a lithium concentrate solution product free of magnesium using a sodium silicate precipitation process. The sample used in this experiment was seawater from the Ancol Lagoon Area in North Jakarta. The seawater used has a high Mg/Li ratio of 10521 and contains 0.1674 ppm lithium ions and 1761 ppm magnesium ions. Before initial processing, seawater with high magnesium levels is not suitable as a raw material for the manufacture of lithium carbonate (active battery ingredient). The variables in the study were the addition of sodium silicate solution in amounts corresponding to 13, 27, 40, 53, 67, 80, 93, and 107% stoichiometry of magnesium ion. One step and multiple stages were used to add sodium silicate solution. The experimental results show that the addition of sodium silicate with 80% stoichiometry is the most effective, as indicated by a decrease in the Mg/Li ratio from 10521 to 64. The limitation of this study is that many lithium ions are still precipitated with magnesium silicate during the precipitation process, so the lithium ions lost in the filtrate reached 82.26% in the single-stage process. As a result, a multi-stage process with six processing steps was used. At single-stage optimum conditions, the sodium silicate addition was 1/6 of the volume of sodium silicate solution. The multi-stage process results could reduce lithium-ion loss in the filtrate from 82.26% to 76.54%. According to the findings of this study, the sodium silicate precipitation process was ineffective in separating lithium and magnesium ions from seawater in both single and multi-stage processes.

Keywords: Magnesium ion separation, lithium ion separation, sodium silicate residue, seawater

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The Effect of Voltage and Time in Synthesis of Manganese Dioxide from Manganese Sulfate Precursor

The utilization of manganese dioxide (MnO_2) as a cathode material for lithium-ion batteries has attracted considerable attention due to its high theoretical storage capacity of 615 mAh/g. In this study, the synthesis of MnO_2 was carried out from manganese sulfate ($MnSO_4$) precursor, a pregnant solution from the leaching process of manganese ore from Trenggalek Regency. The electrolysis method has been used in this synthesis of MnO_2 in an electrochemical cell consisting of two graphite electrodes with dimensions of (16 x 5 x 0.3) cm. The purpose of this study is to determine the effect of voltage and time on particles produced of MnO_2, the phase and crystal structure by MnO_2, and its morphological microstructure. The electrolysis process was carried out in 2,000 ml of $MnSO_4$ solution under constant stirring at 60 °C with DC voltage varied by 2, 4, 6, and 8 volt and time run by 4, 8, 12, and 16 hours. The precipitates formed at the anode were separated, then the particles were dried at 110^{o}C for 2 hours. The composition of MnO_2 was analyzed by XRF (x-ray fluorescence), the phase and crystal structure were evaluated by XRD (x-ray diffraction), and the morphological microstructure was captured by SEM (scanning electron microscope). The results revealed that the highest mass gain of MnO_2 produced is 31.63 grams which are electrolyzed at 8 volts for 16 hours. The highest purity of MnO_2 is 89.23% which is electrolyzed at 2 volts for 16 hours. The particles produced were α-MnO_2 with a tetragonal crystal system and nearly spherical with size particles ranging from 136.01-202.48 and 144-352 nm.

Keywords: Manganese sulfate, manganese dioxide, electrolysis, crystal structure, polymorphy