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PREFACE

The author gives thanks to Allah for bestowing His blessing and direction, allowing the **Metalurgi Journal Volume 39, Edition 3**, **2024** to be successfully published.

The first article results from Aprilia Erryani and colleagues' research activities on *Self-Healing Behavior of Hydrothermally Engineered HAp/PAA Coatings on Magnesium Alloy WE43*. Rizal Tresna and colleagues presented the second article, *Effect of Surface Roughness on Adhesion Strength and Corrosion Resistance of Silica-Epoxy Composite Coated Low Carbon Steel*. Atika Putri Adenia and colleagues' research activities on *Kinetic Modelling of Solid-Liquid Extraction of Tin from Dimethyltin Dichloride by-Product: Effect of Solvent and Stirring Speed*. For the fourth article, Fendy Rokhmanto presented *Corrosion Behavior of Equiatomic CoCrMoMnNb Bio-High Entropy Alloy Fabricated by Multiple Remelting Processes*. The fifth article by Mochamad Achyarsyah and his colleagues discussed *Investigation of Failure Mechanisms in U-Bend Tubes of Shell-and Tube Heat Exchanger*.

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

EDITORIAL

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Self-Healing Behavior of Hydrothermally Engineered HAp/PAA Coatings on Magnesium Alloy WE43

This work examines the self-healing properties and corrosion prevention mechanisms of hydrothermally synthesized HAp/PAA (hydroxyapatite/polyacrylic acid) composite coatings on magnesium alloy WE43. The coatings were produced with different PAA concentrations (0.15, 0.3, and 0.5 wt.%) by a hydrothermal method at 140 °C for 3 hours. The composite layers were analyzed using FTIR (fourier transform infrared spectroscopy), SEM (scanning electron microscopy), and EIS (electrochemical impedance spectroscopy) to assess their structural and electrochemical properties, as well as their self-healing capabilities via a scratch–immersion test in Hank's solution at 37 °C for 48 hours. FTIR analysis confirmed the simultaneous presence of HAp and PAA phases without any chemical reaction, indicating physical contact through hydrogen bonding. The elevation of PAA concentration markedly affected coating morphology, resulting in denser and more uniform structures characterized by spherical HAp crystals at 0.5 wt.% PAA. SEM analysis following scratching and immersion demonstrated that the 0.5 wt.% PAA coating successfully preserved surface integrity and displayed partial restoration of the injured region via the reprecipitation of Ca–P compounds. The EIS findings indicated that the 0.5 wt.% PAA coating maintained the maximum impedance modulus (>10^4 Ω·cm^2) and a steady phase angle after 48 hours of immersion, therefore affirming its exceptional corrosion resistance and self-healing properties. The results demonstrate that an ideal PAA content fosters a dense, ion-responsive hybrid layer that effectively reinstates barrier characteristics following mechanical impairment. The hydrothermally produced 0.5 wt.% HAp/PAA coating offers an efficient self-healing and corrosion-resistant surface for WE43 magnesium alloy, indicating significant potential for use in next-generation biodegradable implant systems.

Keywords: Magnesium WE43, hydroxyapatite, polyacrilic acid, hydrothermal coating, self-healing

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Effect of Surface Roughness on Adhesion Strength and Corrosion Resistance of Silica-Epoxy Composite Coated Low Carbon Steel

Low-carbon steel is widely used in various industries but is susceptible to corrosion in aggressive environments, prompting this study on an epoxy-silica composite coating with variations in silica concentration (0-5 wt.%), sonication dispersion, and surface preparation (abrasive blast cleaning and power tool cleaning); the results showed that abrasive blast cleaning produced a surface roughness of 79 µm and superior adhesion strength (10.48 MPa) compared to power tool cleaning, with a perfect 5A rating in the x-cut tape test for all silica concentrations, while the highest adhesion strength of 14.33 MPa was achieved at 3 wt.% silica, and coating durability tests revealed the best performance exhibiting minimal corrosion propagation of only 0.55 mm after 72 hours at 5 wt.% silica in scratch tests using abrasive blast cleaning, underscoring the significant influence of surface preparation method on coating performance.

Keywords: Epoxy-silica composite, corrosion resistance, surface preparation, adhesion strength, sonication

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Kinetic Modelling of Solid-Liquid Extraction of Tin from Dimethyltin Dichloride by-Product: Effect of Solvent and Stirring Speed

Indonesia is the world's second-largest tin exporter; however, downstream utilization of tin remains limited. One potential source of secondary tin is the by-product generated from the production of DMT (dimethyltin dichloride) at PT Timah Industri, which contains 40–70% tin in both organic and inorganic forms. This study aims to investigate the extraction kinetics and evaluate the effects of solvent type and agitation speed on tin recovery from the DMT by-product. Extraction experiments were conducted using different solvents (water, 50% methanol, and pure methanol) and agitation speeds (300 and 400 rpm) for 24 hours. Tin concentrations in the filtrate were determined using XRF (x-ray fluorescence). Kinetic modeling was performed using first-order and second-order models through both linear and non-linear approaches. The results show that the extraction process follows second-order kinetics, with rate constants (k) in the short-time regime ranging from 0.002 to 0.005 $L\cdot(g\cdot min)^{-1}$ and in the long-time regime from 0.0001 to 0.0002 $L\cdot(g\cdot min)^{-1}$. Water demonstrated the highest dissolution capacity (35.35 ± 0.09%), while pure methanol selectively dissolved organotin compounds (30.45 ± 0.12%). The 50% methanol solvent yielded intermediate extraction results (32.65 ± 0.37%) due to the combined characteristics of both solvents. Agitation speed significantly enhanced tin dissolution.

Keywords: Dimethyltin-dichloride-by-product, solid-liquid-extraction, extraction kinetics, valorization.

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Corrosion Behavior of Equiatomic CoCrMoMnNb Bio-High Entropy Alloy Fabricated by Multiple Remelting Processes

High-entropy alloys are described as equiatomic alloys of more than five elements or materials with five or more element constituents with a high mixing entropy (ΔSmix ≥ 1.5R), where the composition of the element is 5–35%, respectively. One application of HEA (high entropy alloys) materials is in the orthopedic field, where they are developed as biomaterials. Behavior, the correlation between the elemental distribution, and the microstructure of the material were investigated during multiple remelting processes known as Bio-HEAs. The development of Bio-HEAs is exciting in terms of design material, fabrication, and their properties. In this paper, the corrosion behavior and the correlation of the elemental distribution and the microstructure of the material were investigated during the multiple remelting process. The equiatomic CoCrMoMnNb was prepared in vacuum arc melting under an argon atmosphere and melted in a water-cooled copper mold. The total amount of ingot was approximately 25 grams, then flipped and remelted several times, 4, 8, and 12 cycles. The final composition of the alloys was confirmed by EDX (energy dispersive x-ray spectroscopy). The microstructure was investigated with an optical microscope and the SEM (scanning electron microscope). The corrosion parameter occurred in Hank's solution at 37°C, at a scan rate of 1 mV/s. The CCM-MnNb fabricated with 8 cycles of the remelting process exhibits the lowest corrosion rate (0.0038 mmpy) and donor densities (2.67×10^{19} cm^{-3}), while the charge transfer resistance number is the highest (18250.94 Ω cm^{-2}). The outstanding corrosion resistance of the alloys is induced by the presence of the finer dendrites and the chromium oxide (Cr_2O_3) protective layer on the alloy's surface.

Keywords: High entropy alloy, bio-HEA, CoCrMo, biomaterial, remelting cycles, corrosion resistance

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Investigation of Failure Mechanisms in U-Bend Tubes of Shell-and Tube Heat Exchanger

The U-bend tubes of a shell-and-tube heat exchanger made of SA-234 Grade WPB carbon steel failed prematurely within 14 days after replacement and welding. This study investigates failure mechanisms through an integrated failure analysis that includes visual inspection, dye penetrant testing, chemical composition analysis, hardness measurements, and microstructural characterization. The results reveal that the tube contained 0.324 wt.% C, exceeding the maximum limit specified by the standard, which promoted the formation of Widmanstätten ferrite and reduced toughness. The welded joint exhibited multiple defects, including porosity and lack of fusion, which acted as stress concentration sites. Hardness measurements showed average values of 205 HV in the weld metal, 199 HV in the HAZ (heat-affected zone), and 184 HV in the base metal. Under operating conditions of 275 °C and 58.48 barg, these defects progressively opened, leading to fluid leakage. The escaping high-pressure fluid accelerated erosion-corrosion, as evidenced by oxygen-rich corrosion products detected by EDS analysis. The findings demonstrate that the combined effects of material non-compliance, poor welding quality, and unfavorable microstructural evolution governed the premature failure. This study provides quantitative insights to improve welding practices and material selection, thereby enhancing the reliability of U-bend tubes in shell-and-tube heat exchangers.

Keywords: U-bend tube, failure analysis, heat exchangers, steel, widmanstätten