

**PROPERTIES OF BIOCOMPATIBLE Mg-Zn
ALLOY BASED HYBRID COMPOSITE
FABRICATED BY POWDER METALLURGY**

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**PROPERTIES OF BIOCOMPATIBLE Mg-Zn ALLOY BASED HYBRID
COMPOSITE FABRICATED BY POWDER METALLURGY**

by

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LIST OF ABBREVIATIONS

Ar	Argon
BPR	Ball to powder weight ratio
BSE	Back scattered electron
EDX	Energy Dispersive X-ray
FESEM	Field Emission Scanning Electron Microscopy
MA	Mechanical alloying
MMC	Metal Matrix Composite
PM	Powder Metallurgy
XRD	X-ray Diffraction
Co-Cr-Mo	Cobalt-Chromium-Molybdenum
HAP	Hydroxyapatite
Al ₂ O ₃	Alumina
Ti	Titanium
NaCl	Sodium Chloride
Al	Aluminum
Mg	Magnesium
Ca	Calcium
Zn	Zinc

Mn	Manganese
Ta	Tantalum
Nb	Niobium
Ni	Nickel
Li	Lithium
Zr	Zirconium
SiC	Silicon Carbide
RE	Rare Earth
RDA	Recommend Diet Allowance
SBF	Simulated Body Fluid
Mg(OH) ₂	Magnesium Hydroxide
ROM	Rule of Mixture
HBSS	Hanks Balanced Salt Solution
Mg ²⁺	Magnesium ion
HCP	Hexagonal Closed Packed
CaO	Calcium Oxide
PLLA	Poly (lactic acid)
PGA	Poly (glycolic acid)

LIST OF SYMBOLS

2θ	Diffraction angle
Hv	Vickers Hardness
V	Volume
E_{corr}	Corrosion potential
i_{corr}	Corrosion current density
T_m	Melting temperature
MPa	Mega Pascal
GPa	Giga Pascal
BC	Before Christ

SIFAT BIO-SERASI KOMPOSIT HIBRID BERASASKAN ALOI Mg-Zn DIFABRIKASI SECARA METALURGI SERBUK

ABSTRAK

Dalam kajian ini bahan logam biodegradasi dan bioaktif magnesium-zink/hidroksiapatit/alumina (Mg-Zn/HAP/ Al_2O_3) difabrikasi melalui metalurgi serbuk telah dibangun. Objektif utama kajian ini adalah untuk mengkaji kesan kandungan dan nisbah berat partikel HAP dan Al_2O_3 terhadap sifat mekanikal, kakisan, bioaktiviti dan kehausan aloi Mg-Zn. Serbuk Mg, Zn, HAP dan Al_2O_3 dicampur menggunakan pengisar bola tenaga tinggi, dipadat pada 400 MPa dan disinter pada suhu 300°C. Penambahan kandungan Al_2O_3 dari 0 hingga 15 wt. % di dalam hibrid komposit menunjukkan peningkatan kekerasan (57.60 Hv hingga 83.87 Hv) dan kekuatan mampatan (126.48 MPa hingga 244.20 MPa). Berdasarkan ujian polarisasi, 0 wt. % Al_2O_3 komposit (iaitu mengandungi 15 wt. % HAP) adalah paling lengai dengan potensi kakisan (-1.604V), dan paling rendah keamatan arus dan kadar kakisan (0.252 $\mu\text{A}/\text{cm}^2$, 1.25 mm/tahun) hasil daripada pertumbuhan apatit di dalam larutan garam seimbang Hanks (HBSS). Manakala 5 wt. % Al_2O_3 (iaitu mengandungi 10 wt. % HAP) menunjukkan rintangan kehausan paling tinggi disebabkan ketinggian kekerasan Al_2O_3 . Komposit dengan kandungan 20 wt. % (nisbah HAP dan Al_2O_3 2:1) menunjukkan kekerasan rendah (67.03), kekuatan mampatan rendah (138.67 MPa), kadar kakisan tinggi (2.34 mm/tahun) dan rintangan kehausan dengan kehilangan isipadu terendah (4.9 hingga $14.6 \times 10^{-4} \text{ mm}^3$). Keseluruhannya, komposit hibrid dengan penambahan 5 wt.% Al_2O_3 dan 10 wt. % HAP pada nisbah 2:1 mempamerkan keputusan yang paling baik untuk aplikasi implant bioperubatan.

**PROPERTIES OF BIOCOMPATIBLE Mg-Zn ALLOY BASED HYBRID
COMPOSITE FABRICATED BY POWDER METALLURGY**

ABSTRACT

In this study, biodegradable and bioactive metallic material of magnesium-zinc/hydroxyapatite/alumina (Mg-Zn/HAP/Al₂O₃) hybrid composite fabricated by powder metallurgy was developed. The main objective of this work was to investigate the effects of HAP and Al₂O₃ amount of content and weight ratio on mechanical, corrosion and wear behaviour of Mg-Zn based alloy. The powders of Mg, Zn, HAP and Al₂O₃ were mixed in a high energy ball mill, compacted under 400 MPa and sintered at 300°C. The increasing Al₂O₃ content from 0 to 15 wt. % in the hybrid composite resulted in improvement in hardness (57.60 Hv to 83.87 Hv) and compression strength (126.48 MPa to 244.20 MPa). Based on polarization test, 0 wt. % Al₂O₃ composite (i.e. consist of 15 wt. % HAP) is the most noble with corrosion potential (-1.604 V) and the lowest current density and corrosion rate (0.252 μA/cm², 1.25 mm/year, respectively) due to apatite formation in Hanks Balanced Salt Solution (HBSS). While 5 wt. % Al₂O₃ (i.e. with 10 wt. % HAP) shows the highest wear resistance due to high hardness of Al₂O₃. Composite with 20 wt. % ceramic (HAP and Al₂O₃ with 2:1 weight ratio) exhibited low hardness (67.03 Hv), low compressive strength (138.67 MPa), high corrosion rate (2.34 mm/year) and the low volume loss due to wear (4.9 to 14.6 x 10⁻⁴ mm³). Overall, hybrid composite with addition of 5 wt.% Al₂O₃ and 10 wt. % HAP at weight ratio 2:1 displayed the best properties, for biomedical implant application.