Scopus

Documents

Parveez, B.[a] , Jamal, N.A.[a] , Aabid, A.[b] , Baig, M.[b]

Microstructure and Strengthening Effect of Coated Diamond Particles on the Porous Aluminum Composites
(2023) *Materials*, 16 (8), art. no. 3240, . Cited 1 time.

DOI: 10.3390/ma16083240

[a] Department of Manufacturing and Materials Engineering, Kulliyyah of Engineering, International Islamic University Malaysia, Kuala Lumpur, 53100, Malaysia
[b] Department of Engineering Management, College of Engineering, Prince Sultan University, Riyadh, 11586, Saudi Arabia

Abstract
In this work, porous Al alloy-based composites with varying Ti-coated diamond contents (0, 4, 6, 12 and 15 wt.%) were prepared, employing the powder metallurgy route and using a fixed amount (25 wt.%) of polymethylmethacrylate (PMMA) as a space holder. The effects of the varying wt.% of diamond particles on the microstructure, porosities, densities and compressive behaviors were systematically evaluated. The microstructure study revealed that the porous composites exhibited a well-defined and uniform porous structure with good interfacial bonding between the Al alloy matrix and diamond particles. The porosities ranged from 18% to 35%, with an increase in the diamond content. The maximum value of plateau stress of 31.51 MPa and an energy absorption capacity of 7.46 MJ/m3 were acquired for a composite with 12 wt.% of Ti-coated diamond content; beyond this wt.%, the properties declined. Thus, the presence of diamond particles, especially in the cell walls of porous composites, strengthened their cell walls and improved their compressive properties. © 2023 by the authors.

Author Keywords
compressive behavior; diamond particles; PMMA; porous Al composite; space holder technique

Index Keywords
Aluminum alloys, Aluminum coatings, Diamonds, Metallic matrix composites, Porosity, Powder metallurgy; Al composites, Al-alloy, Coated diamonds, Compressive behavior, Diamond particles, Polymethylmethacrylate, Porous Al, Porous al composite, Porous composites, Space-holder techniques; Microstructure

References

- Parveez, B., Jamal, N.A., Maleque, A., Yusof, F., Jamadon, N.H., Adzila, S.
Review on advances in porous Al composites and the possible way forward
(2021) *J. Mater. Res. Technol*, 14, pp. 2017-2038.
- Parveez, B., Jamal, N.A., Anuar, H., Ahmad, Y., Aabid, A., Baig, M.
Microstructure and Mechanical Properties of Metal Foams Fabricated via Melt Foaming and Powder Metallurgy Technique: A Review
(2022) *Materials*, 15.
35955234
- Albayrak, O., Ipekoglu, M., Altintas, S.
Effects of alumina (Al₂O₃) addition on the cell structure and mechanical properties of 6061 foams
(2013) *J. Mater. Res*, 28, pp. 2509-2519.
- Almajid, A.A.
High-temperature deformation of naturally aged 7010 aluminum alloy
(2021) *Metals*, 11.
- Attia, M.S., Meguid, S.A., Tan, K.T., Yeo, S.C.
Influence of cellular imperfections on mechanical response of metallic foams
(2010) *Int. J. Crashworthiness*, 15, pp. 357-367.
- Mu, Y., Yao, G., Liang, L., Luo, H., Zu, G.
Deformation mechanisms of closed-cell aluminum foam in compression

(2010) *Scr. Mater*, 63, pp. 629-632.

- Said, M.R., Tan, C.F.
The response of aluminium foams under quasi-static loading
(2008) *Chiang Mai J. Sci*, 35, pp. 241-249.

- Hamdi, A.A.
Effect Of Magnesium and Tin As Sintering Additives on Microstructure and Compressive Properties of Porous Aluminum
(2018) *Master's Thesis*,
UUM Malaysia, Bukit Kayu Hitam, Malaysia

- Sercombe, T.B.
Non-Conventional Sintered Aluminium Powder Alloys
(1998) *Ph.D. Thesis*,
University of Queensland, St Lucia, QLD, Australia

- Ali, S., Rani, A.M.A., Altaf, K., Baig, Z.
Investigation of Boron addition and compaction pressure on the compactibility, densification and microhardness of 316L Stainless Steel
(2018) *IOP Conf. Ser. Mater. Sci. Eng*, 344, p. 012023.

- Sánchez de la Muela, A.M., García Cambronero, L.E., Malheiros, L.F., Ruiz-Román, J.M.
New Aluminum Syntactic Foam: Synthesis and Mechanical Characterization
(2022) *Materials*, 15.

- Li, Y.G., Wei, Y.H., Hou, L.F., Guo, C.L., Yang, S.Q.
Fabrication and compressive behaviour of an aluminium foam composite
(2015) *J. Alloys Compd*, 649, pp. 76-81.

- Yang, K., Yang, X., He, C., Liu, E., Shi, C., Ma, L., Li, Q., Zhao, N.
Damping characteristics of Al matrix composite foams reinforced by in-situ grown carbon nanotubes
(2017) *Mater. Lett*, 209, pp. 68-70.

- Yang, X., Hu, Q., Li, W., Song, H., Zou, T., Zong, R., Sha, J., Zhao, N.
Compression-compression fatigue performance of aluminium matrix composite foams reinforced by carbon nanotubes
(2020) *Fatigue Fract. Eng. Mater. Struct*, 43, pp. 744-756.

- Wang, J., Yang, X., Zhang, M., Li, J., Shi, C., Zhao, N., Zou, T.
A novel approach to obtain in-situ growth carbon nanotube reinforced aluminum foams with enhanced properties
(2015) *Mater. Lett*, 161, pp. 763-766.

- Alizadeh, M., Mirzaei-Aliabadi, M.
Compressive properties and energy absorption behavior of Al-Al2O3 composite foam synthesized by space-holder technique
(2012) *Mater. Des*, 35, pp. 419-424.

- Chung, C.Y., Chu, C.H., Lee, M.T., Lin, C.M., Lin, S.J.
Effect of titanium addition on the thermal properties of diamond/Cu-Ti composites fabricated by pressureless liquid-phase sintering technique
(2014) *Sci. World J*, 2014, p. 713537.

- Wang, L., Li, J., Che, Z., Wang, X., Zhang, H., Wang, J., Kim, M.J.
Combining Cr pre-coating and Cr alloying to improve the thermal conductivity of diamond particles reinforced Cu matrix composites
(2018) *J. Alloys Compd*, 749, pp. 1098-1105.

- Che, Z., Li, J., Wang, L., Qi, Y., Zhang, Y., Zhang, H., Wang, X., Kim, M.J.
Effect of diamond surface chemistry and structure on the interfacial microstructure and properties of Al/diamond composites
(2016) *RSC Adv*, 6, pp. 67252-67259.

- Yang, B., Yu, J.K., Chen, C.
Microstructure and thermal expansion of Ti coated diamond/Al composites
(2009) *Trans. Nonferrous Met. Soc. China*, 19, pp. 1167-1173.

- Zhang, C., Cai, Z., Wang, R., Peng, C., Qiu, K., Wang, N.
Microstructure and thermal properties of Al/W-coated diamond composites prepared by powder metallurgy
(2016) *Mater. Des*, 95, pp. 39-47.

- Ma, S., Zhao, N., Shi, C., Liu, E., He, C., He, F., Ma, L.
(2017) *Mo 2 C Coating on Diamond: Different Effects on Thermal Conductivity of Diamond/Al and Diamond/Cu Composites*, 402.
Elsevier B.V., Amsterdam, The Netherlands

- Suleiman, M.J., Ahmad, M.A., Mohamed, N., Mohamad Junus, Y., Ibrahim, R., Mohamad, M., Abdul Kadir, M.R., Muhammad, S.
Effect of Atmosphere on the Sintered Titanium Alloy Produced By Metal Injection Molding (Mim) Technique
(2013) *J. Ind. Technol*, 21, pp. 9-17.

- Dong, Y., Zhang, R., He, X., Ye, Z., Qu, X.
Fabrication, and infiltration kinetics analysis of Ti-coated diamond/copper composites with near-net-shape by pressureless infiltration
(2012) *Mater. Sci. Eng. B Solid-State Mater. Adv. Technol*, 177, pp. 1524-1530.

- Zhang, C., Cai, Z., Wang, R., Peng, C., Feng, Y.
Enhancing densification capacity and properties of Al/diamond composites by partial liquid hot pressing
(2017) *Surf. Coat. Technol*, 313, pp. 347-354.

- Abyzov, A.M., Kruszewski, M.J., Ciupiński, Ł., Mazurkiewicz, M., Michalski, A., Kurzydłowski, K.J.
Diamond-tungsten based coating-copper composites with high thermal conductivity produced by Pulse Plasma Sintering
(2015) *Mater. Des*, 76, pp. 97-109.

- Parveez, B., Jamal, N.A., Aabid, A., Baig, M., Yusof, F.
Experimental Analysis and Parametric Optimization on Compressive Properties of Diamond-Reinforced Porous Al Composites
(2023) *Materials*, 16.
36614430

- Kovarik, O., Cizek, J., Yin, S., Lupoi, R., Janovska, M., Cech, J., Capek, J., Chraska, T.
Mechanical and Fatigue Properties of Diamond-Reinforced Cu and Al Metal Matrix Composites Prepared by Cold Spray
(2022) *J. Therm. Spray Technol*, 31, pp. 217-233.

- Sun, Y., Zhang, C., He, L., Meng, Q., Liu, B.C., Gao, K., Wu, J.
Enhanced bending strength and thermal conductivity in diamond/Al composites with B4C coating
(2018) *Sci. Rep*, 8, p. 11104.

- Almajid, A., Walter, R., Kroos, T., Junaidi, H., Gurka, M., Khalil, K.A.
Development of polypropylene/polyethylene terephthalate microfibrillar composites filament to support waste management
(2021) *Polymers*, 13.

- Almajid, A., Walter, R., Kroos, T., Junaedi, H., Gurka, M., Khalil, K.A.
The multiple uses of polypropylene/polyethylene terephthalate microfibrillar composite structures to support waste management—composite processing and properties
(2021) *Polymers*, 13.

- Aboraia, M., Sharkawi, R., Doheim, M.A.
Production of aluminium foam and the effect of calcium carbonate as a foaming agent
(2011) *J. Eng. Sci*, 39, pp. 441-451.

- Nakamura, T., Gnyloskurenko, S.V., Sakamoto, K., Byakova, A.V., Ishikawa, R.
Development of new foaming agent for metal foam
(2002) *Mater. Trans*, 43, pp. 1191-1196.

- Mukherjee, M., García-Moreno, F., Jiménez, C., Rack, A., Banhart, J.
Microporosity in aluminium foams
(2017) *Acta Mater*, 131, pp. 156-168.

- Jiang, B., Wang, Z., Zhao, N.
Effect of pore size and relative density on the mechanical properties of open cell aluminum foams
(2007) *Scr. Mater*, 56, pp. 169-172.

- Mohd Razali, R.N., Abdullah, B., Ismail, M.H., Ahmad, U.K., Idham, M.F., Rasmli, A.
Mechanical properties of aluminium foam by conventional casting combined with NaCL space holder
(2013) *Appl. Mech. Mater*, 393, pp. 156-160.

- Krommenhoek, M., Shamma, M., Morsi, K.
Processing, characterization, and properties of aluminum–carbon nanotube open-cell foams
(2017) *J. Mater. Sci*, 52, pp. 3927-3935.

- Jamal, N.A., Maizatul, O., Anuar, H., Yusof, F., Nor, Y.A., Khalid, K., Zakaria, M.N.
Preliminary development of porous aluminum via powder metallurgy technique
(2018) *Mater. Werkstofftech*, 49, pp. 460-466.

- Tan, P.P., Mohamad, H., Anasyida, A.S.
Properties of Porous Magnesium Using Polymethyl Methacrylate (PMMA) as a Space Holder
(2018) *J. Phys. Conf. Ser*, 1082, p. 012063.

- Li, B.Q., Wang, C.Y., Lu, X.
Effect of pore structure on the compressive property of porous Ti produced by powder metallurgy technique
(2013) *Mater. Des*, 50, pp. 613-619.

- Bi, Y., Zheng, Y., Li, Y.
Microstructure and mechanical properties of sintered porous magnesium using polymethyl methacrylate as the space holder
(2015) *Mater. Lett*, 161, pp. 583-586.

- Baumeister, J., Banhart, J., Weber, M.
Aluminium foams for transport industry
(1997) *Mater. Des*, 18, pp. 217-220.

- Showaiter, N., Youseffi, M.
Compaction, sintering and mechanical properties of elemental 6061 Al powder with

and without sintering aids
(2008) *Mater. Des*, 29, pp. 752-762.

- Kang, B., Kong, T., Dan, N.H., Phuong, D.D., Ryu, H.J., Hong, S.H.
Effect of boron addition to microstructure and mechanical properties of refractory Al 0.1 CrNbVMo high-entropy alloy
(2021) *Int. J. Refract. Met. Hard Mater*, 100, p. 105636.

- Dixit, M., Srivastava, R.
The effect of copper granules on interfacial bonding and properties of the copper-graphite composite prepared by flake powder metallurgy
(2019) *Adv. Powder Technol*, 30, pp. 3067-3078.

- Miyoshi, T., Hara, S., Mukai, T., Higashi, K.
Development of a closed cell aluminum alloy foam with enhancement of the compressive strength
(2001) *Mater. Trans*, 42, pp. 2118-2123.

- German, R.M., Rabin, B.H.
Enhanced sintering through second phase additions
(1985) *Powder Metall*, 28, pp. 7-12.

- Hassani, A., Bagherpour, E., Qods, F.
Influence of pores on workability of porous Al/SiC composites fabricated through powder metallurgy + mechanical alloying
(2014) *J. Alloys Compd*, 591, pp. 132-142.

- Bekoz, N., Oktay, E.
Effects of carbamide shape and content on processing and properties of steel foams
(2012) *J. Mater. Process. Technol*, 212, pp. 2109-2116.

- Yang, K., Yang, X., Liu, E., Shi, C., Ma, L., He, C., Li, Q., Zhao, N.
Elevated temperature compressive properties and energy absorption response of in-situ grown CNT- reinforced Al composite foams
(2017) *Mater. Sci. Eng. A*, 690, pp. 294-302.

- Mizuuchi, K., Inoue, K., Agari, Y., Morisada, Y., Sugioka, M., Tanaka, M., Takeuchi, T., Makino, Y.
Processing of diamond particle dispersed aluminum matrix composites in continuous solid-liquid co-existent state by SPS and their thermal properties
(2011) *Compos. Part B Eng*, 42, pp. 825-831.

- Parveez, B., Jamal, N.A., Raeez, M.
Investigation of Morphology and Compressive Properties of Diamond Reinforced Porous Aluminium Composites
(2023) *Asian J. Fundam. Appl. Sci*, 4, pp. 12-17.

- Kwon, H., Leparoux, M., Heintz, J.M., Silvain, J.F., Kawasaki, A.
Fabrication of single crystalline diamond reinforced aluminum matrix composite by powder metallurgy route
(2011) *Met. Mater. Int*, 17, pp. 755-763.

- Yang, X., Zou, T., Shi, C., Liu, E., He, C., Zhao, N.
Effect of carbon nanotube (CNT) content on the properties of in-situ synthesis CNT reinforced Al composites
(2016) *Mater. Sci. Eng. A*, 660, pp. 11-18.

- Amore, S., Ricci, E., Borzone, G., Novakovic, R.
Wetting behaviour of lead-free Sn-based alloys on Cu and Ni substrates
(2008) *Mater. Sci. Eng. A*, 495, pp. 108-112.

- Lasky, R.C.
Copper-Tin intermetallics: Their importance, growth rate, and nature
Proceedings of the SMTA International 2018 Conference Brochure,
Rosemont, IL, USA, 14–18 October 2018

- Jiang, M.G., Xu, C., Nakata, T., Yan, H., Chen, R.S., Kamado, S.
Development of dilute Mg-Zn-Ca-Mn alloy with high performance via extrusion
(2016) *J. Alloys Compd*, 668, pp. 13-21.

- Mota, J.M., Martinez, M.A., Velasco, F., Criado, A.J.
Preparation of aluminium boride by powder technology
(2004) *Ceram. Int*, 30, pp. 301-306.

- Kayikci, R., Kurtulus, O., Gurbuz, R.
The formation and growth behavior of aluminium boride crystals in an Al-B alloy
(2009) *Solid State Phenom*, 144, pp. 140-144.

- Ebhota, W.S., Jen, T.-C.
Intermetallics Formation and Their Effect on Mechanical Properties of Al-Si-X Alloys
(2018) *Intermet. Compd.-Form. Appl*, pp. 21-41.

- Zhang, Y., Wang, X., Jiang, S., Wu, J.
Thermo-physical properties of Ti-coated diamond/Al composites prepared by pressure infiltration
(2010) *Mater. Sci. Forum*, 654–656, pp. 2572-2575.

- Al-Dabbagh, J.B., Tahar, R.M., Ishak, M., Harun, S.A.
Structural and phase formation of TiAl alloys synthesized by mechanical alloying and heat treatment
(2015) *Int. J. Nanoelectron. Mater*, 8, pp. 23-32.

- Pal, U., Sandoval, A., Madrid, S.I.U., Corro, G., Sharma, V., Mohanty, P.
Mixed titanium, silicon, and aluminum oxide nanostructures as novel adsorbent for removal of rhodamine 6G and methylene blue as cationic dyes from aqueous solution
(2016) *Chemosphere*, 163, pp. 142-152.

- Jamal, N.A., Tan, A.W., Yusof, F., Katsuyoshi, K., Hisashi, I., Singh, S., Anuar, H.
Fabrication and compressive properties of low to medium porosity closed-cell porous Aluminum using PMMA space holder technique
(2016) *Materials*, 9.

- Linul, E., Marsavina, L., Ková, J.
Collapse mechanisms of metal foam matrix composites under static and dynamic loading conditions
(2017) *Mater. Sci. Eng. A*, 690, pp. 214-224.

- Salur, E., Nazik, C., Acarer, M., Şavklıyıldız, İ., Akdoğan, E.K.
Ultrahigh hardness in Y2O3 dispersed ferrous multicomponent nanocomposites
(2021) *Mater. Today Commun*, 28, p. 102637.

- Aldoshan, A., Khanna, S.
Effect of relative density on the dynamic compressive behavior of carbon nanotube reinforced aluminum foam
(2017) *Mater. Sci. Eng. A*, 689, pp. 17-24.

Correspondence Address
Jamal N.A.; Department of Manufacturing and Materials Engineering, Malaysia; email: ayuni_jamal@iium.edu.my

Publisher: MDPI

ISSN: 19961944

Language of Original Document: English
Abbreviated Source Title: Mater.
2-s2.0-85156152081
Document Type: Article
Publication Stage: Final
Source: Scopus