Pengaruh Penguat Hibrid SiC/Grafit terhadap Karakteristik Balistik Komposit Al-(10-12)Zn-5Mg = Effects of SiC/Graphite Hybrid Reinforcement on Ballistic Characteristic of Al-(10-12)Zn-5Mg Composites

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Abstrak

Penelitian tentang komposit untuk aplikasi armor saat ini mendapat banyak perhatian. Komposit matriks aluminium merupakan salah satu material yang potensial untuk mensubstitusi baja sebagai material utama dalam industri militer. Dengan pemilihan penguat yang baik, peningkatan karakteristik balistik dapat dicapai melalui peningkatan kekerasan serta keuletan. Penelitian ini mempelajari pengaruh penguat hibrid SiC dan grafit terhadap sifat mekanik dan mikrostruktur Al-(10-12) Zn-5Mg. Penguat grafit dan SiC ditambahkan dengan kombinasi jumlah target: 10% SiC-0%, grafit, 8% SiC-2% grafit, 6% SiC-4% grafit, dan 0% SiC-4% grafit. Komposit dibuat dengan squeeze casting dengan waktu pengadukan 2 menit. Sampel kemudian diberi laku penuaan pada suhu 200º C selama 2 jam untuk meningkatkan ketangguhan. Karakterisasi yang dilakukan adalah pengujian komposisi kimia, pengamatan struktur mikro dan Scanning Electron Microscope-Energy Dispersive Spectroscopy (SEM-EDS), X-Ray Diffraction (XRD), perhitungan porositas, analisis distribusi kuantitatif penguat, pengujian kekerasan, uji impak, uji tarik dan terakhir dilakukan pengujian balistik dengan peluru tipe III berkaliber 7,62 x 51 mm sesuai standar NIJ 0108.04. Pada penelitian ini didapatkan fraksi volume penguat aktual adalah sebagai berikut: 6.8% SiC-0% grafit, 4.7% SiC - 2% grafit, 3.2% SiC-1.9% grafit, dan 0% SiC-4% grafit Hasil penelitian menunjukkan bahwa sifat mekanik komposit yang difabrikasi sangat dipengaruhi oleh kehadiran porositas daripada penambahan penguat SiC maupun grafit. Penambahan SiC pada komposit meningkatkan porositas lebih tinggi dibandingkan penambahan grafit. Hal ini disebabkan karena kekerasan dan morfologi SiC menciptakan aglomerasi berjarak (interparticle spacing) pada saat proses pengadukan. Oleh karena itu, komposit dengan fraksi volume SiC tertinggi memiliki porositas yang tinggi yaitu 5,8%, yang mengalami penurunan dengan penurunan fraksi volume SiC. Nilai kekerasan terendah 66,34 HRB diperoleh pada komposit dengan penguat 6,8% SiC-0% grafit kemudian menurun seiring penurunan fraksi volume SiC dan penambahan grafit dengan nilai masing-masing : 71,9 HRB, 73,82 HRB, 75,54 HRB pada fraksi volume 4,7% SiC- 2% grafit, 3,2% SiC-1,9% grafit, 0% SiC-4% grafit. Selain itu, karena dominasi porositas tersebut, maka tidak terdapat perbedaan yang signifikan pada nilai impak maupun kuat tarik dan keuletan karena mekanisme deformasi melalui pergerakan dislokasi tidak berfungsi akibat besarnya porositas tersebut. Disisi lain, struktur mikro matriks komposit memiliki fasa kedua seperti MgZn2, Mg3Zn3Al2 dan Fe-Al Intermetallic. Pada pengujian balistik, ketiga pelat komposit tidak mampu menahan peluru tipe III akan tetapi pelat kedua dan ketiga pecah tanpa perforasi ......Research on composite material for armor application is recently taken a lot of attention. Aluminium matrix composite is a promising candidate to substitute the commonly used steel as the main materials in military industries. Improvement of ballistic behaviour maybe achieved through increment of hardness as well as ductility, by using suitable reinforcement. This research studied the effect of SiC and graphite hybrid reinforcement on mechanical properties and microstructure of Al-(10-12)Zn-5Mg. SiC and graphite reinforcement were added in combination with targeted amount of : 10% SiC-

0% graphite, 8% SiC-2% graphite, 6%SiC-4% graphite, and 0% SiC-4% graphite. The composite was fabricated through squeeze casting with 2 minutes stirring time. Samples were precipitation strengthened at 200°C for 2 hours to improve the toughness. Samples were characterized by Optical Emission Spectroscopy (OES), hardness test, impact test, tensile test, microstructure analysis using optical microscope and Scanning Electron Microscopy - Energy Dispersive Spectroscopy (SEM), quantitative metallography to calculate porosity and reinforcement distribution, and type III ballistic testing with 7.62 x 51 mm bullet in accordance with NIJ 0108.04 standard. The results showed that the actual volume fraction of the reinforcement is as follows: 6.8% SiC-0% graphite, 4.7 % SiC-2% graphite, 3.2% SiC-1.9% graphite and 0%SiC-4% graphite. The role of porosity is more dominant in determining the mechanical properties of composites than the role of reinforcement. Addition of SiC is easier to trap porosity than that of the graphite. This is due to the high hardness and sharp-edged morphology of SiC that creates interparticle spacing during stirring. Therefore, the composite with the highest volume fraction of SiC had a high porosity of 5. 8%, which decreased with a decrease in the volume fraction of SiC. The lowest hardness value of 66.34 HRB was obtained in the composite with 6.8% SiC-0% graphite as reinforcement and then strengthened with reduced SiC and added graphite, respectively 71.9 HRB, 73.82 HRB, 75.54 HRB at a volume fraction of 4.7% SiC-2% graphite, 3.2% SiC-1.9% graphite, 0% SiC-4% graphite. There was no significant difference in the impact values, tensile strength, and ductility since the deformation mechanism through dislocation movement did not work due the large amount of porosity. The microstructure of the composite matrix confirmed the presence of a second phase such as MgZn2, Mg3Zn3Al2 and Fe-Al. The ballistic testing showed that the composite plates were not able to withstand type III bullets but the second and third plates fragmented without perforation.