ABSTRACT

Aluminum-silicon alloys are notable materials owing to their fine thermal conductivity, low expansion coefficient and good corrosion that can be utilized in the fields of automotive industry such as cylinder blocks, cylinder heads, brake discs, pistons and valve lifters. Modification of melt treatment in Al-Si cast alloys leads to a change in the morphology of eutectic silicon, resulting in mechanical properties enhancement. This enhancement affects the machinability of Al-Si alloys (i.e. cutting forces, surface roughness, tool wear and chip morphology). Near-eutectic alloys are the most difficult to machine of the various Al-Si alloys because, the silicon phase present is almost ten times harder than the aluminum base alloy, which rapidly increases tool wear, these difficulties have thus created the need for a more in-depth understanding of the effects of microstructure on the machinability of these alloys.

Compared with other techniques, melt treatment with addition of inoculation agents known as modifier or refiner elements is more practical method due to low production cost and suitability for general engineering applications. Despite previous studies on microstructure of Al-Si alloys, there is lack of information on the effect of Bi, Sb and Sr additions that extensively address the influence of these elements on machinability characteristics of Al-11Si-2Cu cast alloy when dry turning. Understanding the machinability of these alloys is imperative when it is necessary to fabricate some industrial products which are produced by casting process. Therefore, the aim of this research was to investigate the machinability characteristics of Al-11 Si2Cu alloy containing bismuth, antimony and strontium when dry turning using coated carbide inserts. The influence of additional elements on mechanical properties was also investigated by conducting hardness, tensile and impact tests.

Machining of workpieces was completed using a CNC turning machine (ALPHA 1350S) with an 8.3 kW power drive. Various cutting speeds of 70, 130 and 250 m/min and various feed rates of 0.05, 0.1 and 0.15 mm/rev were employed. Pure Bi shots, pure Sb and Sr granules at concentrations of 1wt.%, 0.5.% and 0.04.% were selected based on the optimum concentration for each additive as determined by microscopic inspection.

The results indicated that surface roughness and cutting force decreased with increasing cutting speed from 70 m/min to 250 m/min, additionally, change of silicon morphology from flake-like to lamellar structure affects the machinability parameters. It was found that the Bi-containing workpiece had the best surface roughness value and lowest cutting force due to formation of pure Bi which acts as lubricant on the machined surface, while Sr-containing workpiece produced the highest cutting force and highest surface roughness value. Bi-containing alloy produced segmentation chips (C-shape) in comparison with other alloy elements, which led to separation of chip segments at outer (free) surface. Sr and Sb-containing alloys increased ductility of alloys which led to the production of massive BUE during machining process, resulting in increased flank wear. Impact test shows that absorbed energy value for the base alloy was around 1.15J, whereas it increased to 2.2J for Sr treated alloy.

ABSTRAK

Aloi aluminium-silikon adalah bahan yang terkenal kerana kekonduksian mereka halus haba, pekali pengembangan rendah dan kakisan yang baik yang boleh digunakan dalam bidang industri automotif seperti blok silinder, kepala silinder, cakera brek, piston dan lifters injap. Pengubahsuaian rawatan leburan dalam Al-Si *cast alloy* aloi membawa kepada perubahan dalam morfologi silikon eutektik, menyebabkan peningkatan sifat mekanik. Peningkatan ini memberi kesan kepada di mesin aloi Al-Si (iaitu daya pemotongan, kekasaran permukaan, pemakaiam alat dan cip morfologi). Hampir-eutektik aloi adalah yang paling sukar untuk mesin pelbagai aloi Al-Si kerana, fasa silikon ini adalah hampir sepuluh kali lebih keras daripada aloi aluminium asas, menyebabkan peningkatanyany pesat dalam penggunaan alat, masalah ini manjadi sebab alat ini dicipta sebgani keperluan untuk pemahaman yang lcbin mendalam mengenai kesan mikrostruktur atas di mesin aloi ini.

Berbanding dengan teknik-teknik lain, rawatan pancairan dengan penambahan agen inokulasi dikenali sebagai pengubahsuai atau panulunam logam unsur-unsur adalah kaedah yang lebih praktikal kerana kos pengeluaran yang rendah dan kesesuaian untuk aplikasi kejuruteraan am. Walaupun kajian sebelum ini pada mikrostruktur aloi Al-Si, terdapat kekurangan maklumat mengenai kesan Bi, Sb dan penambahan Sr dalam menangani pengaruh elemen-elemen ini pada ciri-ciri di mesin Al-11Si-2Cu membuang aloi apabila perubahan kering. Memahami mesin aloi ini adalah penting apabila ia adalah perlu untuk fabnkasi beberapa barangan perusahaan yang dihasilkan oleh proses pemutus. Oleh itu, tujuan kajian ini adalah untuk menyiasat ciri-ciri mesin aloi Al-11 Si2Cu mengandungi bismut, antimoni dan strontium apabila perubahan kering menggunakan sisipan karbida bersalut. Pengaruh unsur-unsur tambahan ke atas sifat mekanik juga disiasat dengan menjalankan kekerasan, tegangan dan kesan ujian.

Pemesinan bahan kerja telah disiapkan menggunakan CNC menjadikan mesin (ALPHA 1350-an) dengan memandu kuasa 8.3 kW. Pelbagai kelajuan pemotongan 70, 130 dan 250 m / min dan pelbagai kadar suapan 0.05, 0.1 dan 0.15 mm / put telah. Tembakan Bi tulen, suci dan Sb Sr granul pada kepekatan 1wt.%, 0.5.% Dan 0.04.% telah dipilih berdasarkan kepekatan optimum bagi setiap tambahan seperti yang ditetapkan oleh pemeriksaan mikroskopik.

Keputusan menunjukkan bahawa kekasaran permukaan dan daya pemotongan menurun dengan peningkatan kelajuan pemotongan dari 70 m / min 250 m / min, tambahan, perubahan silikon morfologi daripada kepingan seperti struktur lamela memberi kesan kepada parameter di mesin. Ia telah mendapati bahawa Bi bans mengandungi bahan kena mumli ki nilai kekasaran permukaan tubaik dan daya pemotongan paling rendah kerana pembentukan Bi thlun yang bertindak sebagai pelincir pada permukaan mesin, manakala Sr yang mengandungi bahan kerja tela manghassilkan daya pemotongan tertinggi dan paling tinggi nilai kekasaran permukaan. Bi yang mengandungi aloitelah manghasilkan chip segmentesi jika dihasilkan (C-bentuk) dibandingkan dengan unsur-unsur aloi lain, yang membawa kepada pemisahan segmen cip di luar permukaan (purmnkam bebas) Aloi Sr dan Sb telah meningkat kemuluran aloi yang membawa kepada pengeluaran besar-besaran BUE semasa proses pemesinan, menyebabkan bertambah haus rusuk. Menunjukkan nilai tenaga untuk aloi asas ialah sekitar 1.15J, sedangkan ia meningkat kepada 2.2J untuk aloi dirawat Sr.

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