UNIVERSITI TEKNOLOGI MARA

EFFECT OF BORON AND CARBON-ADDED TITANIUM FILLER ON MICROSTRUCTURE AND MECHANICAL PROPERTIES OF β-TITANIUM ALLOY WELDMENTS

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AUTHOR'S DECLARATION

I declare that the work in this thesis was carried out in accordance with the regulations of Universiti Teknologi MARA. It is original and is the result of my own work, unless otherwise indicated or acknowledged as referenced work. This thesis has not been submitted to any other academic institution or non-academic institution for any degree or qualification.

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ABSTRACT

Demand for high performance and weld joint increases due to advancement of technology in automobile and aerospace industries. Microstructural and mechanical properties of metastable beta Titanium (β-Ti) weldments can be improved by grain refinement and formation of insoluble precipitates in the weld. Also, the morphology and distribution of α precipitate shows significant influence on mechanical properties of metastable beta titanium alloy. Upon cooling, welded metastable beta titanium alloys exhibit retained β phase and for autogenous weld of these alloys shows inferior mechanical properties causes by coarse and columnar grain. In this research, the addition of boron and carbon into the weld by using modified filler of metastable beta titanium, Ti-15V-3Cr-3Sn-3Al (Ti-15-3) results in reduction of grain size and formation of insoluble precipitate. The application of pulsed current (PC) further improves the mechanical properties by further refining the grain and causes the grain to become more equiaxed. X-ray diffraction and scanning electron microscopic analysis revealed the presence of β-Ti phase in the weldments prepared without the filler modification, while additional TiB and TiC phases are observed in the weldments prepared with fillers modified with B and C, respectively. B and C addition to the fillers has resulted in the grain refinement of the weldments and the grain size reduction is seen to be higher with the increasing B and C addition. The formation of TiB, TiC and growth restriction effect due to the presence of B and C in the filler resulted in the decreased grain size of the β-Ti weldments. Mechanical properties such as hardness, tensile strength and creep is improved up till 14 - 26 % due to addition of B and C in Ti-15-3 weld. The improvement of mechanical properties is contributed by grain refinement and formation of TiB and TiC precipitates in weldments. Post-weld heat treatment (PWHT) of all Ti-15-3 alloys weld show formation of α precipitate. However, the micrograph for weld with the addition of B and C results in better distribution and finer α precipitate. For PWHT sample, the weld prepared by using C-modified fillers shows best mechanical properties followed by weld prepared by using B-modified filler and lastly weld prepared autogenously. Compared to as-welded sample, PWHT samples show superior mechanical properties in term of hardness and tensile strength.

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