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Materials Characterization 58 (2007) 312–317

MATERIALS CHARACTERIZATION

A study on the re-solution heat treatment of AA 2618 aluminum alloy

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Received 3 May 2006; accepted 4 July 2006

Abstract

In the present study, the effects of re-solution treatment of AA2618 aluminum alloy has been investigated. Solution heat treatments of 520–640 °C for 14–24 h were applied followed by artificial aging. Characterization studies that were carried out by optical microscopy, scanning electron microscopy and energy dispersive X-ray spectroscopy techniques showed that recrystallisation was not observed by solution treatment at 530 °C whereas it did occur as the solution treatment and the duration time were increased above 530 °C. Increasing the solution treatment temperature further coarsened both the grains and the precipitates, resulting in significant reduction in hardness. Al_9FeNi-type intermetallics are not completely dissolved by these solution treatments.

Keywords: 2618 Aluminum alloy; Age hardening; Solution heat treatment; Recrystallisation

1. Introduction

At the present time, technological demands for materials having high strength to weight ratio, high specific modulus, low coefficient of thermal expansion, good wear resistance, low density and good thermal conductivity are constantly increasing. Aluminum offers one answer for the combinations of such attractive properties. The aluminum alloy 2618, which contains copper and magnesium, is especially attractive due to its age hardenable properties. These alloys are used for applications involving high temperature exposures up to 300 °C, such as engines for both automotive (engine cylinder heads, pistons etc.) and aircraft applications. This alloy was successfully used as the primary structure of the supersonic Concorde airplane [1,3].

The use of a solution treatment-plus-aging heat treatment for the 2618 aluminum alloy allows machining to a smoother finish than is the case for annealed or water quenched conditions. Solution heat treatment is done at 530 °C for a period of time which may be extended up to 24 h for thick sections following by water quenching [4]. As a result of cold work, annealing may be required, and is usually limited to

Table 1
The chemical composition of aluminum 2618 alloy, values are in wt.%

Cu	Mg	Ni	Fe	Si	Ti	Mn	Al
2.19	1.43	0.9	0.96	0.17	0.05	0.035	Balance

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doi:10.1016/j.matchar.2006.07.002

Table 2
Durations (h) and temperatures (°C) of the solution heat treatments

Sample no.	Solution heat treatment temperature, °C							Quenching
	520	530	545	560	575	600	640	
1	12 h	–	–	–	–	–	–	Salt+ice
2	–	14 h	–	–	–	–	–	“
3	–	24 h	–	–	–	–	–	“
4	–	24 h	+1/2 h	–	–	–	–	“
5	–	–	–	1 h	–	–	–	Water
6	–	–	–	1 h	+1 h	–	–	“
7	–	–	–	1 h	+1 h	+1 h	–	“
8	–	–	–	1 h	+1 h	+1 h	+1/4 h	“

approximately 385 °C for 4 h followed by slow cooling. The aging heat treatment (T 61) is accomplished by first solution treating at 530 °C for up to 24 h (depending on section size) followed by a quench in boiling water and subsequent aging at 200 °C for up to 20 h (minimum of 5 h) dependent upon section size [2].

At the present study, selected properties of solution heat treated 2618 aluminum alloy were evaluated. The starting samples were extruded and thermally aged. Generally, some regions were not fully recrystallized, and all precipitates were not dissolved by the treatments used. Brinell hardness tests, optical and scanning electron microscopy, and energy dispersive X-ray spectroscopy were used to understand the reasons for the incomplete recrystallization and particle dissolution.

Determining the optimum solution treatment conditions is a major consideration in the fabrication of 2618 alloy. Therefore, the present study was conducted to characterize the microstructures of 2618 aluminum alloy as a function of solution treatment conditions.

2. Experimental details

Aluminum 2618 alloy used in this study was in the form of extruded angular bar with the chemical composition given in Table 1. The samples were cross-sectioned from the supplied bar having dimensions of 10×10×10 mm.

The solution heat treatment program used for the samples is shown in Table 2. The heat treatments were performed in an electrical resistance furnace having temperature variation of ±1 °C under atmospheric

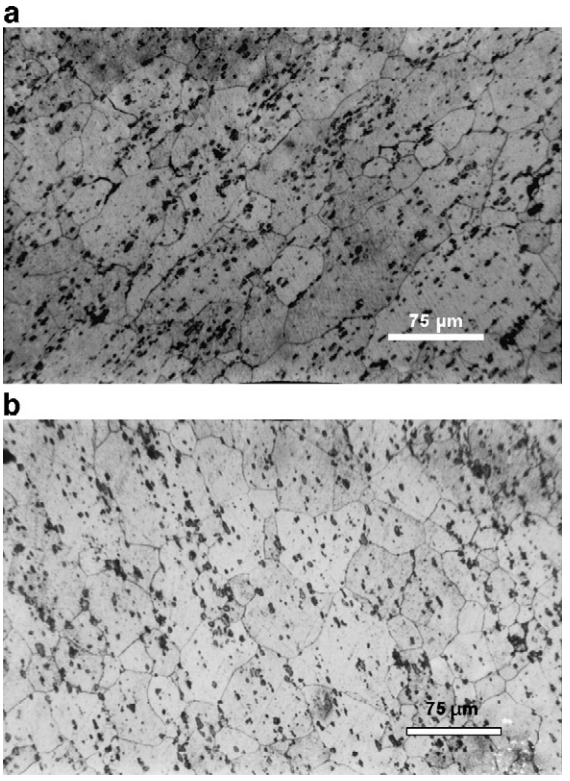

Fig. 1. Optical microscopy cross-sectional view of non-treated 2618 aluminum alloy; (a) in the extrusion direction, (b) perpendicular to the extrusion direction.

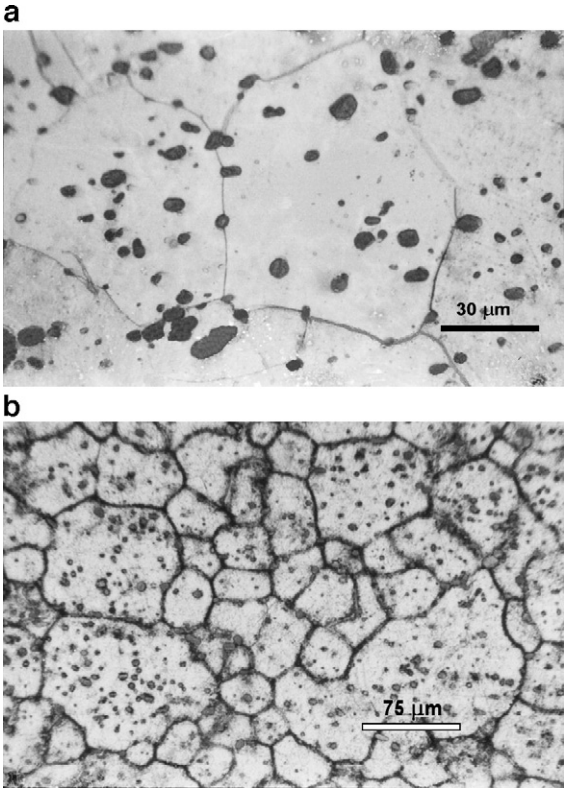

Fig. 2. Optical microscopy cross-sectional view of solution treated samples; (a) at 530 °C for 24 h (sample 3), (b) at 530 °C for 24 h +545 °C for 1/2 h (sample 4).