EFFECT OF THERMO-EXPOSURE ON PROPERTIES OF 8090 Al-Li EXTRUSION

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Abstract

Tensile properties at different test temperature of 8090-T8510 extrusion in the as-recieved condition and thermo-exposed at different temperature for 50 hours are investigated and compared with those of LY12CS (2024-T8) and LY16 (2219) alloy. Strength reduction of alternative immersion of 8090-T8510 extrusion exposed at different temperature is also investigated.

Intruduction

As a new generation of aerospace material, Al-Li alloys have been developed for their low density, high specific strength and high specific stiffness. In the past years, a series of Al-Li alloy such as 2090, 2091, 8090, 1420 have been developed and many product forms such as sheet, plate, extrusion and forging are produced[1-3]. Considering the technical sophistication and usage factor of material, 8090 extrusion would be one of the prior cadidates for the aircraft construction[4]. Properties of 8090 alloy have been intensively investigated, but little paper about its properties in elivated temperature especialy the effect of thermo-exposure has been published. Materials used in aircraft generally worked in a certain temperature enviroment, for instance, elements subjected to aerodynamic heating or worked near high temperature zone. It is necesary to investigate the effect of thermo-exposure on properties of 8090 extrusion. This paper presented the investigation results and compared to correspending properties of LY12CS (2024-T8) and LY16 (2219) alloys [5]which would be replaced by 8090 alloy.

Material and Experiment Procedure

Chemical composition of the alloy investigated is as follows (wt%)

Li	Cu	Mg	Zr	Ti	Fe	Si	Al
2.51	1.15	0.82	0.12	0.04	<0.05	<0.05	bal

The alloy was melt in protect atmosphere. A diameter of 120 mm round ingot was produced by semi-continuously direct chill (DC) casting. The ingot was homogenized, scaled and extruded. The shape of extrusion is shown in Fig 1. T8510 temper is solid soluted, stretched and artificial aged at 190℃ for 16 hours. The specimens are cut from the extrusion. Thermo-exposure has been conducted in a dry oven with recycle air at 100, 125, 150, 175, 200 and 250℃ for 50 hours respectivelly. Alternative immersion is in solusion of 3% NaCl + 0.1%H_2O_2 for 5 min. and in air for 25 min. maintaining for 30 days. Microstructure is examined using a H800 TEM.

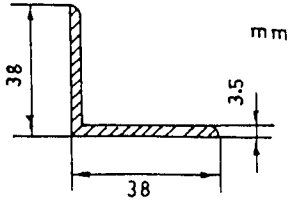

Fig. 1 Shape of extrusion

Results and Discussion

High Temperature Tensile Properties of 8090-T8510 Extrusion

Fig. 2 shows the dependance of tensil properties of 8090 alloy on test temperature in T8510 temper. As a comparison the data of LY12CS (2024-T8) and LY16 (2219) alloys are taken from a handbook [5]. Tensile properties of 8090 alloy decreases from 515 MPa to 195 MPa, elongation increases from 5.7% to 28% when the test temperature rises from room temperature to 250℃. LY12CS and LY16 alloy have the same trend except the elongation of LY16 alloy. Strength of 8090 alloy is higher than that of LY12CS and LY16 up to 150℃ and 200℃ respectively.

High temperature properties of thermo-exposed 8090-T8510 extrusion is shown in Fig3. Tensile proterties tested at thermo-exposure temperature also shows that the strength

decreases and elongation increases as the exposure temperature rises. The strength reducing and elongation increasing is more rapidlly to compare with the material without thermo-exposed, i. e. in the temper of T8510. The strength of 8090 alloy is higher than that of LY12CS and LY16 alloy up to 150℃ and 175℃ respectively.

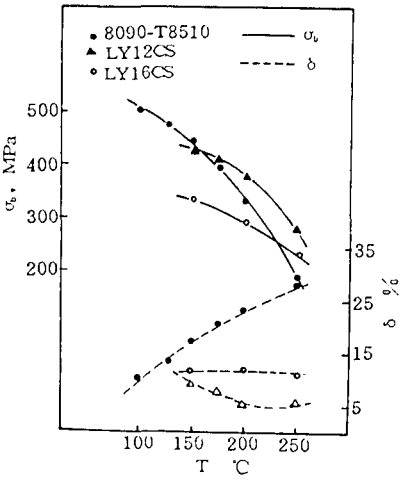

Fig. 2 High temperature tensile properties of 8090-T8510, LY12 and LY16 alloys

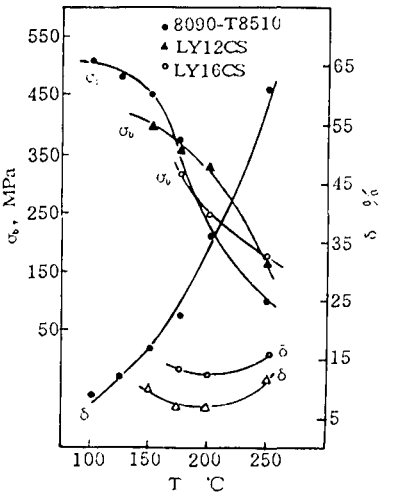

Fig. 3 High temperature tensile properties of 8090-T8510, LY12 and LY16 alloys thermo-exposed at different temperature

Effect of Thermo-Exposure on Room Temperature Properties.

Dependence of room temperature properties on exposure temperature is shown in Fig4. With exposure temperature rising the tensile strength of 8090 alloy increases until 150℃, then begins to decrease. Behaviour of LY12 and LY16 alloy is different. The strength decreases continously. The strength of 8090 is higher than that of LY12 and LY16 until exposed at 175℃ and 200℃ respectively. The increase of strength for 8090 alloy thermo-exposed up to 150℃ is due to age process during the thermo-exposure. 8090 alloy in T8510 temper is near peak aged. It becomes peak aged after exposure at 150℃, strength reaches maximum. After that it becomes over aged leading to strength

decreasing and elongation increasing. Fig. 5 shows the microstructure change with thermo-exposure. It can be seen that δ′ and S′ phase gradually grows up from under aging, peak aging to over aging.

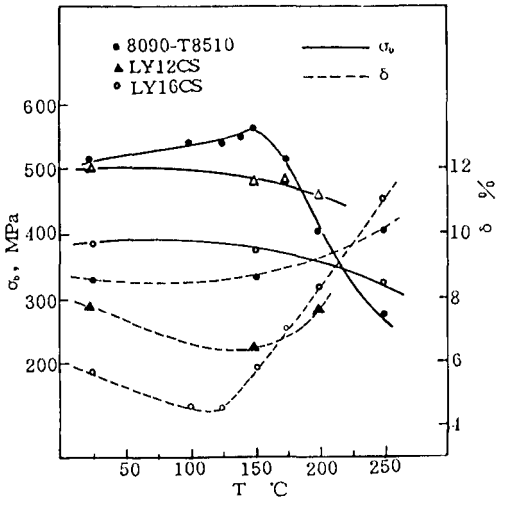

Fig. 4 Room temperature properties of 8090-T8510, LY12 and LY16 alloys thermo-exposed at different temperature

Stength Reduction of Alternative Immersion

Strength reduction caused by alternative immersion for 8090 extursion after thermo-exposrue at different temperature for 50 horus is listed in table 1.

Tab. 1 Strength Reduction of Alternative Immersion

Thermo-exposure	YS MPa			UTS MPa			El %		
	before corrosion	after corrosion	reduction %	before corrosion	after corrosion	reduction %	before corrosion	after corrosion	reduction %
100 C/50h	471	443	5.9	542	460	14.8	4.6	1.9	58.7
125 C/50h	471	443	5.9	540	454	15.9	4.6	1.9	58.7
150 C/50h	488	462	5.3	562	473	15.8	5.8	1.4	75.9
175 C/50h	495	427	7.0	526	449	14.6	7.0	1.7	75.7

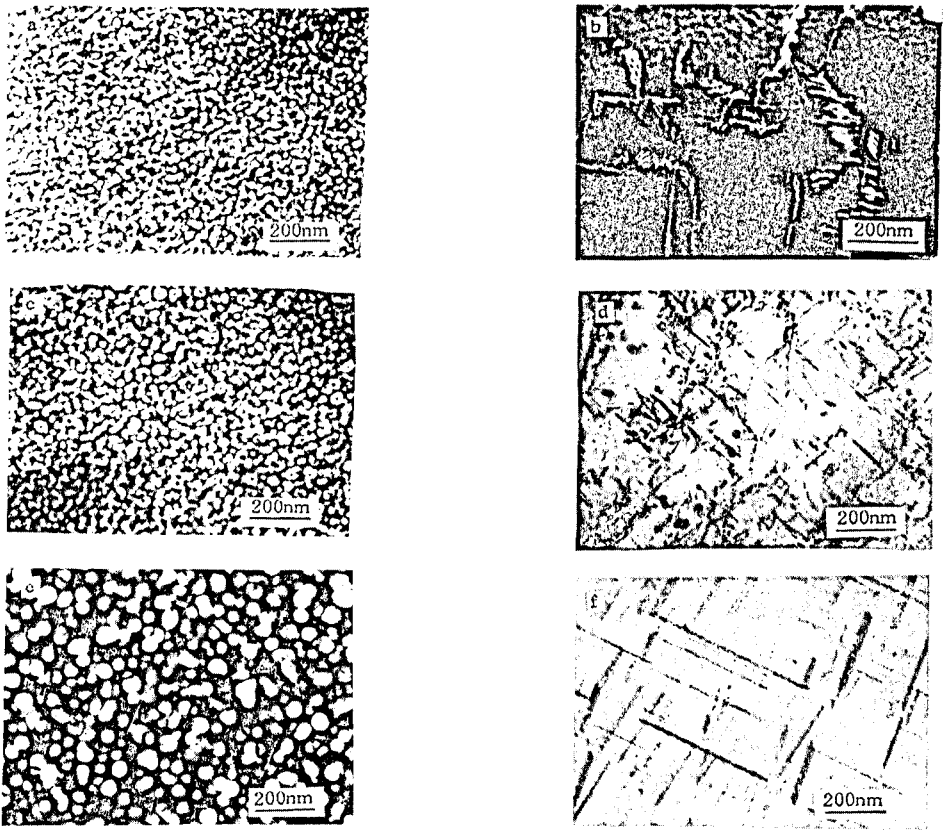

Fig. 5 δ′ and S′ phase of 8090-T8510 (a, b), and thermo-exposed at 150℃ (c, d) and 250℃ (e, f).

Due to alternative immersion ultimate strength reduction is about 15～16%, yield strength reduction is obut 5～7%. They are not sensitive to differece of thermo-exposure temperature between 100～175℃. Reduction of elongation is abut 60～75%, which is more serious than strength reduction. This may be caused by the corrosion pits at the sample surface.

Conclusions

1. Tensile strength of 8090-T8510 extrusion decreases with test temperature rising either in the as-received condition or in the thermo-exposed condition, but the strength decrease is more rapid in the later case.
2. Tensile strength of 8090 extrusion is higher than that of LY12CS and LY16 when test temperature is below 150℃ even the material has subjected to thermo-exposure for 50 hours.
3. Room temperature strength increases with thermo-exposure temperature rising from 100℃ to 150℃. Above 150℃ it begins to decrease. These is caused by the further aging process during thermo-exposure.
4. Strength reduction caused by alternative immersion is not obvious for the alloy thermo-exposed below 175℃, but elongation reduction is more obvieous. Stength reduction is not sensitive to difference of thermo-exposure temperature in the range of 100℃ to 175℃.

References

1. R. Grimes, et al. Aluminum-Lithium Alloys Vl, DGM Infomationsgesellschaft. verlag (1991). P. 3
2. R. H. Graham, R. J. Rioja, J. M. Newman, ibid. P. 15
3. I. N. Fridlyander, A. G. Bratuhin, V. G. Davydov. ibid. P. 35
4. W. Zink, J. Weilke, ibid. P. 987
5. Aeronatical Materials Handbook of China (in chinese), Vol. 3, National Standard Publishing House of China (1989).