Effect of thermal cycling on CuAlAg shape memory alloys

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Abstract

Shape memory alloys with high transformation temperatures open new potential field of applications. Therefore, new complex alloys are developing. CuAlAg also have shape memory properties at temperatures above 200ºC. One of the main problems concerning these alloys is the thermal stability of them when cycling because the high temperatures involved can promote diffusion and then the development of new equilibrium phases. The aim of this work is to study the effect of the thermal cycling on the stability of SME and to follow the loss of SME as a result of DSC cycling. The structural evolution was examined by SEM, DSC and X-Ray diffraction using a heating holder that allows heating the samples. Different alloy compositions have been studied. There is a thermal degradation of the transformation because of the presence of equilibrium phases that change with cycling. A decrease of the transformation temperatures was found. Also the results show that the dependence of the amount of transformation with cycle number is not dependent of the composition for Ag contents from 4 to 15 wt%.

Introduction

- CuAlAg alloy exhibit SMA properties at higher temperatures than CuZnAl or CuAlBe alloys
- Small addition of Ag (1%) is needed to get SMA characteristics
- The stability of this alloy with temperature and composition is an important factor that controls the SMA behavior.

Experimental Procedure

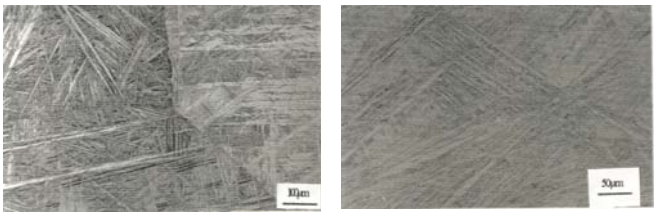
Cu-Al-Ag compositions

Sample	Ag	Al	Cu	e/a
Ag1	1.0	10.9	88.1	1.45
Ag2	2.0	12.8	85.2	1.52
Ag5	3.1	10.7	86.2	1.44
Ag8	4.0	12.4	83.7	1.51
Ag10	4.1	12.3	83.6	1.50
Ag12	4.8	10.3	84.9	1.43
Ag13	6.0	12.8	81.2	1.52
Ag14	6.4	12.0	81.6	1.50
Ag16	8.0	12.8	79.2	1.53
Ag17	14.0	10.1	75.9	1.44
Ag18	14.9	11.3	73.8	1.49

Thermal treatment

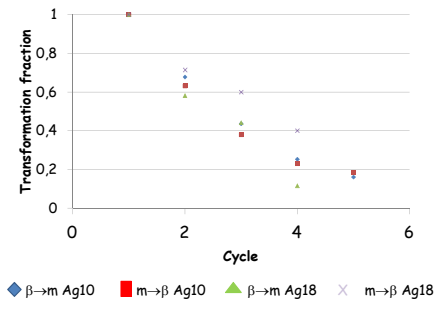
Treatment	T (°C)	Time (min)
Heating	900	15
Quench	100	1
Cooling	Room Temp	--

Cu-Al-Ag at RT: martensitic (AG0 and AG3)



Transformation temperatures (°C) during cycling

Cycle	Ms (°C)	Mf (°C)	As (°C)	Af (°C)	$\Delta H_{\beta\rightarrow m}$ (KJ/Kg)	$\Delta H_{m\rightarrow\beta}$ (KJ/Kg)
1	214	84	257	429	4.3	3.5
2	220	92	259	432	2.5	2.5
3	188	79	260	428	1.9	2.1
4	198	75	251	428	0.5	1.4



Results and discussion

Initial transformation temperatures (°C)

Sample	Ms	Mf	As	Af
Ag1	245	135	290	380
Ag2	243	115	290	360
Ag5	289	154	387	495
Ag8	236	96	308	355
Ag10	286	190	292	418
Ag12	284	180	267	450
Ag13	230	139	277	441
Ag14	237	118	231	321
Ag16	196	116	NT	NT
Ag17	266	157	273	402
Ag18	213	84	257	429

Conclusions

- Cu-Al-Ag exhibit high martensitic transformation temperatures
- The alloys have large hysteresis and transformation interval
- Thermal degradation properties occurs easily when cycling

Acknowledgements

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