Experimental Report

22/07/2015

Proposal: **1-01-129** **Council:** 10/2012

Title: The study of the phase diagram forFe-Al-Ge alloy. Its relation to the mechanical and magnetic behavior.

This proposal is a new proposal

Researh Area: Materials

Main proposer: **PEREZ DE LANDAZABAL Jose Ignacio**

Experimental Team: LAMBRI Agustin
PEREZ DE LANDAZABAL Jose Ignacio
RECARTE Vicente

Local Contact: CUELLO Gabriel Julio

Samples: 5 different samples (at.%): Fe-4Al-8Ge, Fe-8Al-4Ge, Fe-13Al-12 Ge, Fe-20Al-5Ge, Fe-25Al-2.5Ge

Instrument	Req. Days	All. Days	From	To
D20	3	3	29/08/2014	01/09/2014

Abstract:

There exists very scarce information in the literature about the ternary Fe-Al-Ge system, which is related to some partial isotherm. In addition, information concerning the mechanical and magnetic properties of the Fe-Al-Ge system seems to be absent in the literature. The use of Fe-Al-Ge alloys in technological applications depends mainly on the brittle and creep behaviour at high temperatures. Dislocations and grain boundary mobility are the two most important mechanisms controlling the creep behaviour at high temperatures. Therefore, it is crucial to know the evolution of the phases in this ternary system, since it has a strong influence on the dislocation and grain boundary mobility. Consequently “in situ” neutron diffraction must be performed for determining the evolution of the phases in this ternary system.
Neutron thermo diffraction is the most appropriate technique for studying the temperature phase transitions due to the short time involved to obtain the full spectra during the heating ramp in contrast to standard X-ray studies.
For this proposal, 5 different samples (at.%): Fe-4Al-8Ge, Fe-8Al-4Ge, Fe-13Al-12 Ge, Fe-20Al-5Ge, Fe-25Al-2.5Ge;
will be used.

The study of the phase diagram for Fe-Al-Ge system. Its relation to the mechanical and magnetic behaviour

Binary Fe-Ge alloys with high solute concentration (around 25 at.%) and with long-range ordered structures have gained increasing interest owing to their extremely high mechanical strength at elevated temperatures and unusual magnetic behaviour [1]. However, the addition of a third element such as aluminium to Fe-Ge alloys is usually done in order to improve the brittle behaviour of these alloys. To our knowledge there exists very scarce information in the literature about the ternary Fe-Al-Ge system, which is related to some partial isotherm [2]. The use of Fe-Al-Ge alloys in technological applications depends mainly on the brittle and creep behaviour at high temperatures. Therefore, it is crucial to know the evolution of the phases in this ternary system, since it has a strong influence on the dislocation and grain boundary mobility. In fact, dislocations and grain boundary mobility are the two most important mechanisms controlling the creep behaviour at high temperatures [3, 4]. Previous work on Fe–Al–Si alloys exhibiting $D0_3$ order [3], show that the mobility of dislocations and grain boundaries is controlled by the atomic order degree. More recently [4,5] a discussion about the mobility of dislocations inside grains and at the grain boundaries together with a deep study about the grain boundary mobility was made in Fe-Al-Cr where $D0_3$ and B2 order appear.

A single sample $FeAl_4Ge_8$ was measured due to problems with the vacuum and furnace oxidation; the sample was obtained by casting high purity metals, under controlled atmosphere, from the induction melted metals. The specimen was homogenized at 1360 K under high vacuum and quenched into room temperature water. Heating-Cooling-Heating-Cooling thermal cycles at 5ºK /min between room temperature and 973 K have been carried out in order to determine the appearance of precipitation processes, phase transitions or atomic order changes by thermo-diffraction in D20. Different heating ramps were performed.

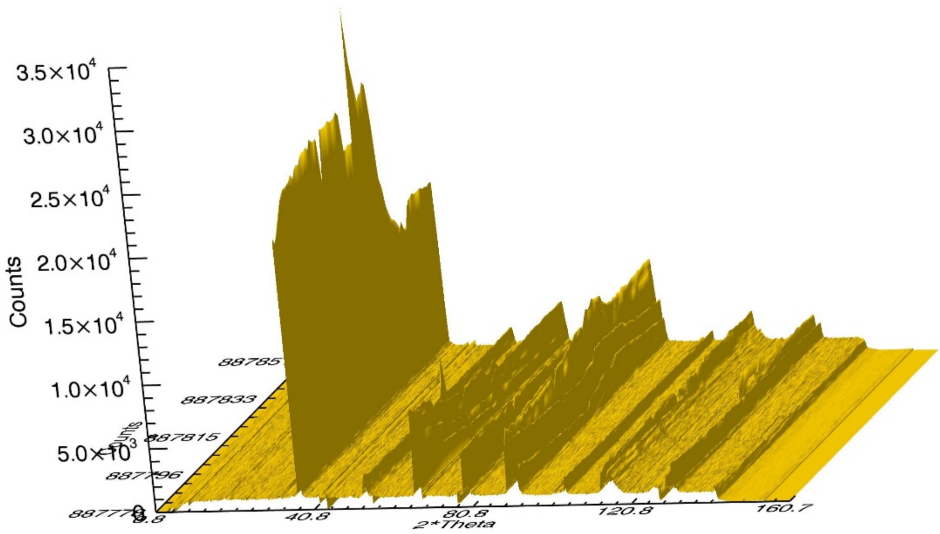

Figure 1: Thermo-diffraction measurements carried out on a heating ramp from RT to 673 K in $FeAl_4Ge_8$

Figure 1 shows as an example one these thermo-diffraction measurements carried out on a heating ramp from RT to 673 K.

References

[1] I.S. Golovin, H. Neuhaeuser, H.-R. Sinning, C. Siemers, Intermetallics 18 (2010) 913.
[**2**] V. Raghavan, J. Phase Eq. 23 (2002) 437.
[**3]** O.A. Lambri, J.I. Pérez-Landazábal, G.J. Cuello, J.A. Cano, V. Recarte, C. Siemers, I.S. Golovin, J. of Alloys and Comp., 468 (2009) 96.
[4] O. A. Lambri, J. I. Pérez-Landazábal, V. Recarte, G. J. Cuello, I. S. Golovin, J. of Alloys and Comp., 537 (2012) 117.
[5] O. A. Lambri, J. I. Pérez-Landazábal, D. Gargicevich, V. Recarte, F.G. Bonifacich, G. J. Cuello, V. Sanchez-Alarcos. Mater. Trans. JIM 56 (2015)182.