Study of nano precipitation in aluminum alloys

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I arrived at the University of Toyama on June 17, 2009 and worked until July 16, 2009, approximately one month. My duties were to work with and report to Professor Kenji Matsuda. There were two research areas that I worked on during my stay. The first was to work on the thermodynamics and growth of GP zones in aluminum alloys with silver solute. The second area of effort was to examine the chemical thermodynamics of the transition between non-equilibrium γ' phase and the equilibrium γ phase in another aluminum-silver alloy (Al-Ag).

The work on GP zones involved examining the work of graduate student Mr. Hiroaki Daicho with advisors Prof. Matsuda and Prof. Ikeno. The title of the paper we are working on is *HRTEM Observation of GP Zones in Al-Ag Alloys.* The effort entails a very close examination of the growth morphology of Guinier-Preston (G.P.) zones in an Al-15mass%Ag alloy that was investigated by a high resolution transmission electron microscopy (HRTEM). From the literature, Al-Ag G.P. zones are considered to be truncated octahedrons which have facets of {111} and {100} planes between the matrix and the GP zone interphase boundary. The percentage of faceting along the interphase boundary is the subject of this work. The examination is to understand the percentage change in faceting with respect to time, alloy composition and temperature. By performing the heat treatments at a constant temperature, thermodynamic potentials can be considered in the analysis. With aging temperature increasing the faceting percentage decreases, in agreement with previous literature reports. Facets are dominant at lower aging temperature and smaller diameter G. P. zones. The latter finding is contrary to the published literature. The other contribution of this work is that three different alloys were investigated and the work showed that silver content of the alloy and G.P. zone size are also important.

The conclusions to date from the effort are that when G.P. zones in an Al-15 mass%Ag alloy aged at several temperatures were observed by HRTEM, the GP zones revealed facets at their interface along {111} and {100} planes of the matrix (see Fig. 1). Facets of {111} planes develop rather than {100} planes. Also, the facets are more prevalent at lower aging temperatures and smaller sizes of G. P. zones. The reason that facets depend on the size of G.P. zones rather than aging temperature is not clear yet.

The second research effort by Shiflet was to work on how the metastable phase, γ', becomes the equilibrium phase γ. The title of the publication we are working on is *Variation in Composition of* $\gamma' \rightarrow \gamma$ *Precipitates in Al-Ag Alloys* and the authors are K. Matsuda, G.J. Shiflet, S.Ikeno. The work was begun at the University of Virginia by Prof. Matsuda when he visited my lab several years ago.

The chemical composition and information on crystal structure of the γ' and γ phase were taken from precipitates in two aluminum alloys, one contained 16% silver and the other 30 mass% silver. The microscope used to collect the data was a field-emission TEM at the University of Virginia.

The difference of the crystal structure between the γ′ and γ phase was not detected by CBDP and SADP analysis, so both phases have the same space group of P63/mmc. Silver compositions in precipitates increased from Ag/Al=1.5 to Ag/Al=2.0 with increasing aging time at a constant aging temperature. Based on our results, the difference between γ′ and γ phase is only due to increasing silver content leading to the loss of coherency of the γ′ plate. In other words, the lattice parameter changes with increasing silver composition. Calculations of elastic strain are being done presently to compare theory with our experimental results. Based on these results, a new form of the Gibbs free energy plot (G-x diagram) will be constructed to finally explain this long studied system.

These results will be published on the 12th International Conference on Aluminum Alloys (ICAA-12) on September 2010 in Yokohama, Japan.

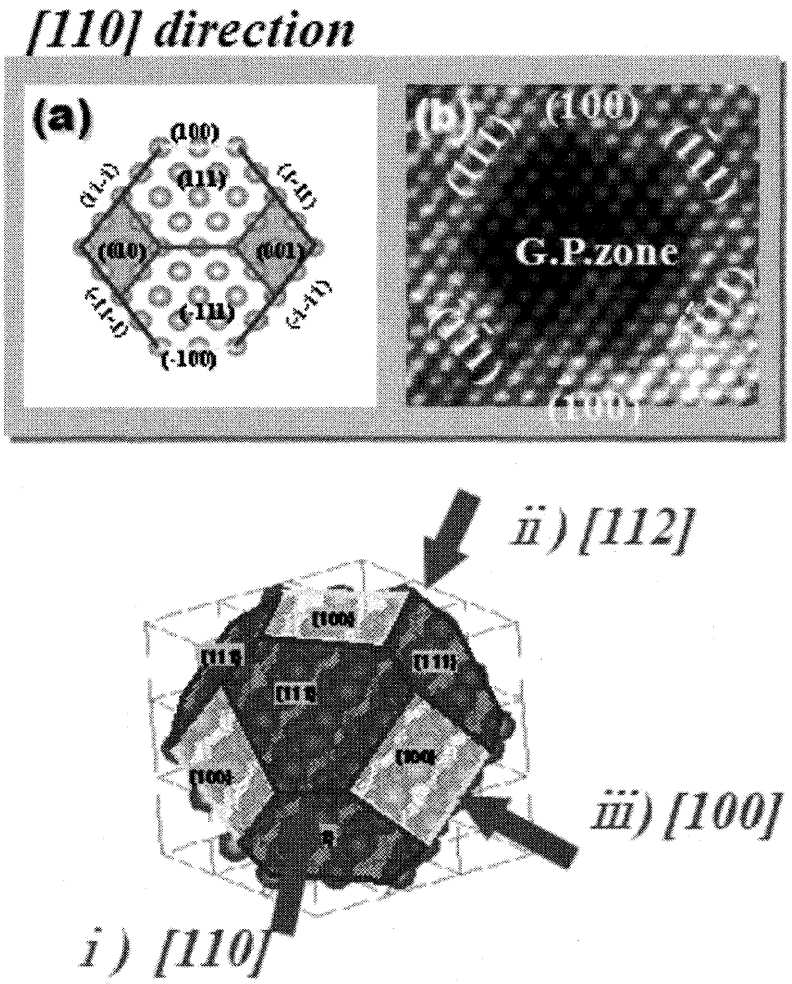

Fig. 1 HRTEM image and schematic illustrations of the G.P. zone in Al-Ag alloy