The Electron Diffraction Study of Al-Cu-Mg Alloy Containing GPB Zones and S Phase Precipitates

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The aluminum alloy Al-2.5Cu-1.5Mg wt. % with peak hardness, widely used in structuralaerospace applications, was examined with a Philips CM12 TEM (120 Kv). It has been reported in the literature [*e.g.*, 1] that this alloy contains a rod-like coherent GPB zones and fine S phase precipitates (S phase; Al2CuMg with Cmcm; a=0.400 nm, b=0.923 nm, c=0.714 nm [2]), and that dispersions of the zones and the S phase precipitates are responsible for the hardness of the alloy. However despite extensive studyfor this alloy, the structure such as of GPB zone and even their diffraction pattern (DP) are still not well understood. The purpose of this work is to enhance the understanding of this complex alloy.

Select Area Diffraction Patterns: Fig. 2a and Fig. 3a show the near (001) and (011) DPs respectively. The patterns show weak diffraction spots and diffuse streaks with the matrix Al strong diffraction spots. For the DP pattern of Fig. 2a, there areconflicting reports such as that the weak reflections were due to those from S phase dispersion and the diffuse streaks from GPB zones [1] or exclusively from S phase precipitates[3,4].

Fig. 2b and Fig. 3b are the simulated diffraction patterns from a proposed GPB model in Fig. 1, with the small cylindrical shape, 2.2 nm in diameter and 16 nm in length. Fig. 2c and Fig. 3c are those from fine rods of S phase with the dimension of 2216nm. It should be noted that the patterns added the b) to the c) give very good agreements with the observed the a) patterns. Therefore it can be concluded that contrary to previous reports in [1,2,3], the coherent GPB zone diffraction streaks are only prominent near nodes of the matrix as discussed in [5], while the streaks from S phase precipitates show little relationship to the nodes of the matrix.

References

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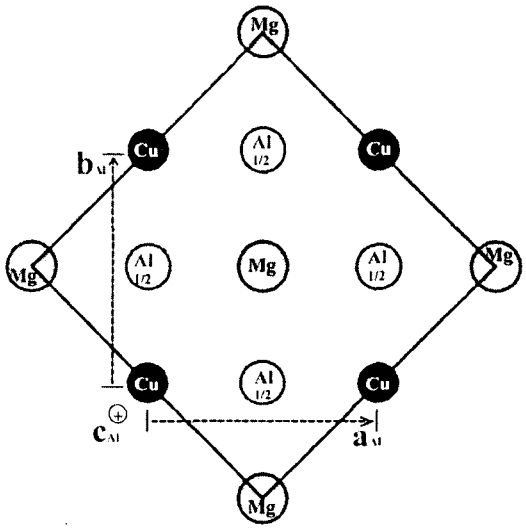

Fig. 1. The structure of a proposed GPB (Guinier-Preston-Bagaratsky) zone model (Al2CuMg) which gives good agreement with observations. The tetragonal cell (a=0.415 nm, c=0.405 nm) with the space group P4/mmm (No. 123). In the figures, the z coordinates of Cu and Mg atoms are zero, i.e. in the first layer of (001) plane of the matrix and the Al atoms are at the z = , i.e. in the second layer of the (001) plane.

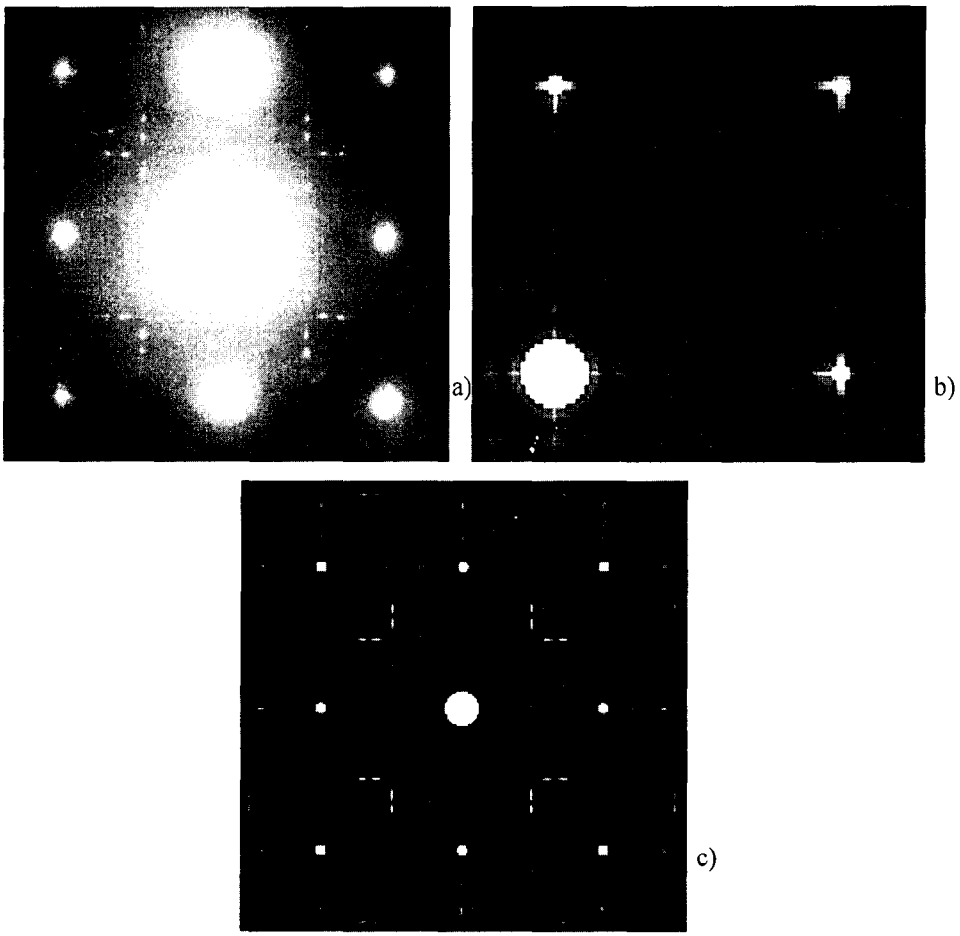

Fig. 2.The a) is the (001) diffraction pattern from the Al-Cu-Mg alloy after aging for 500 h at 150C (peak hardness). In this pattern all weak spots were identified with reflections from S phase precipitates. The b) shows the simulated (001) DP corresponding to one fourth of the DP in a), consisting of strong reflections from the matrix and streaks from the GPB zone model structure in Fig. 1. The c) is the simulated diffraction pattern from S phase precipitates and the matrix. It should be noted that the pattern added the b) to the c) give very good agreement with the observed DP in the a).

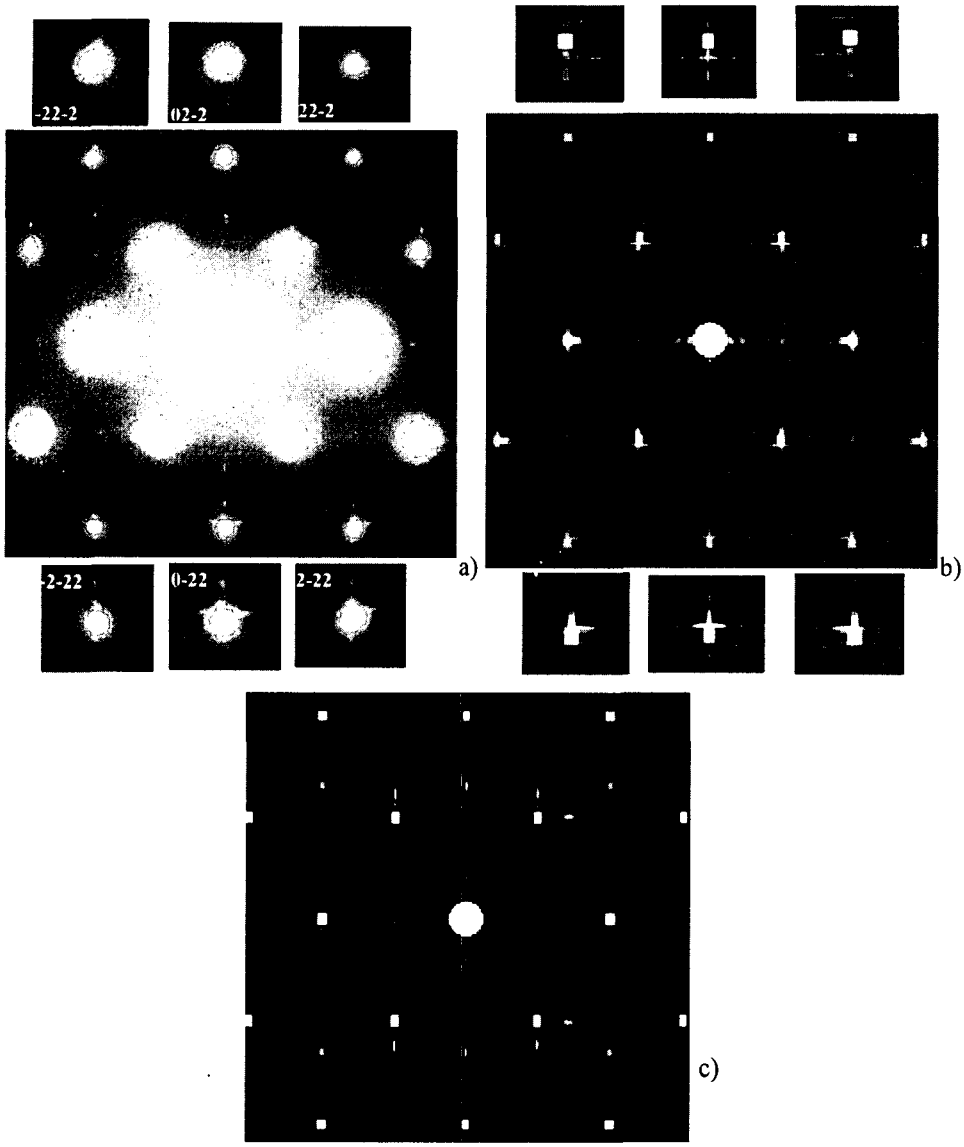

Fig. 3. The a) is the DP with (011) orientation which shows weak reflections around particularly {111}matrix reflections and diffuse streaks. The b) and the c) are the simulated DP near (011) orientation with the GPB zone model and S phase precipitates, respectively.It is noted that the adding DP pattern of b) and c) give excellent agreement with the observed pattern in the a).