# Introduction

A large number of researchers have studied that the effects of manganese content addition to the microstructure changes of Cu-Al binary alloys. [1-38] Based on these studies, it is found that the addition of manganese would not only stabilized and expanded the $\beta$-phase(disordered body-centered cubic) field but also decreased the martensite start (Ms) critical temperature of the Cu-Al binary alloys.[1-7] Particularly, the phase transitions in the $Cu_{3-x}Mn_xAl$ alloys with $0 \leqq X \leqq 1.0$ were extensively studied. In 1976, M. Bouchard and G. Thomas have established the $Cu_{3-x}Mn_xAl$ alloys with $0 \leqq X \leqq 1.0$ metastable phase diagram by using thermal analysis method, as shown in Figure 1 [1]. In that phase diagram, it is seen that when the $Cu_{3-x}Mn_xAl$ alloys with $0.2 \leqq X \leqq 0.8$ were solution treated in the single $\beta$ phase (disordered body-centered cubic (b.c.c.)) region followed by a rapid quench into iced brine, a $\beta \rightarrow B2 \rightarrow D0_3+L2_1$ phase transition would occur by an ordering transition and a spinodal decomposition process, respectively. When the manganese (Mn) content of the alloy was increased to 25 at. pct. (x=1), the as-quenched microstructure of the $Cu_2MnAl$ alloy became a single $L2_1$ phase. The crystal structure of the $L2_1$ ($Cu_2MnAl$) phase is similar to the $D0_3$ ($Cu_3Al$) phase, and the only difference between them is that manganese replaces the copper at a specific lattice sites with eight nearest copper atoms in the $D0_3$ structure so as to form a stoichiometric composition of $Cu_2MnAl$ [1], as shown in Figures 2. In addition to the thermal analysis method, x-ray diffraction and transmission electron microscopy (TEM) were also used by many other researchers to examine the as-quenched microstructures of the $Cu_{3-x}Mn_xAl$ alloys with $0.5 \leqq x \leqq 1.0$ [22-25]. These were found to be consistent with those proposed by Bouchard et al.

Recently, we performed TEM observations on the phase transformation of a $Cu_{2.2}Mn_{0.8}Al$ alloy [25]. Our experimental result indicated that the as-quenched microstructure of the $Cu_{2.2}Mn_{0.8}Al$ alloy consisted of a mixture of ($D0_3$+$L2_1$+L-J) phases, where the L-J phase is a new phase having an orthorhombic structure with lattice parameters a=0.413 nm, b=0.254 nm and c=0.728 nm. The orientation relationship between the L-J phase and the matrix was $(100)_{L-J}$ // $(0\bar{1}1)_m$, $(010)_{L-J}$ // $(0\bar{1}\bar{1})_m$ and $(001)_{L-J}$ // $(211)_m$. The rotation axis and rotation angle between two variants of the L-J phase were [021] and 90 deg [25]. It is worthwhile to note here that the L-J phase had never been found previously by other workers in the Cu-Al, Cu-Mn and Cu-Mn-Al alloy systems.

To date, all of the transmission electron microscopy examination were focused on the $Cu_{3-x}Mn_xAl$ alloy systems with $0.5 \leqq X \leqq 1.0$. Little information concerning the $Cu_{3-x}Mn_xAl$ alloys with lower manganese content has been provided. Besides, in the $Cu_{3-x}Mn_xAl$ metastable phase diagram (Figure

1.), it is seen that A2 $\rightarrow$ B2 transition temperature of the $Cu_{3-x}Mn_xAl$ alloy with $x < 0.5$ is uncertain. Therefore, the purpose of the present study is to investigate the as-quenched microstructure of the $Cu_{3-x}Mn_xAl$ alloys with $X < 0.5$ by using optical microscopy (OM) and transmission electron microscopy (TEM).

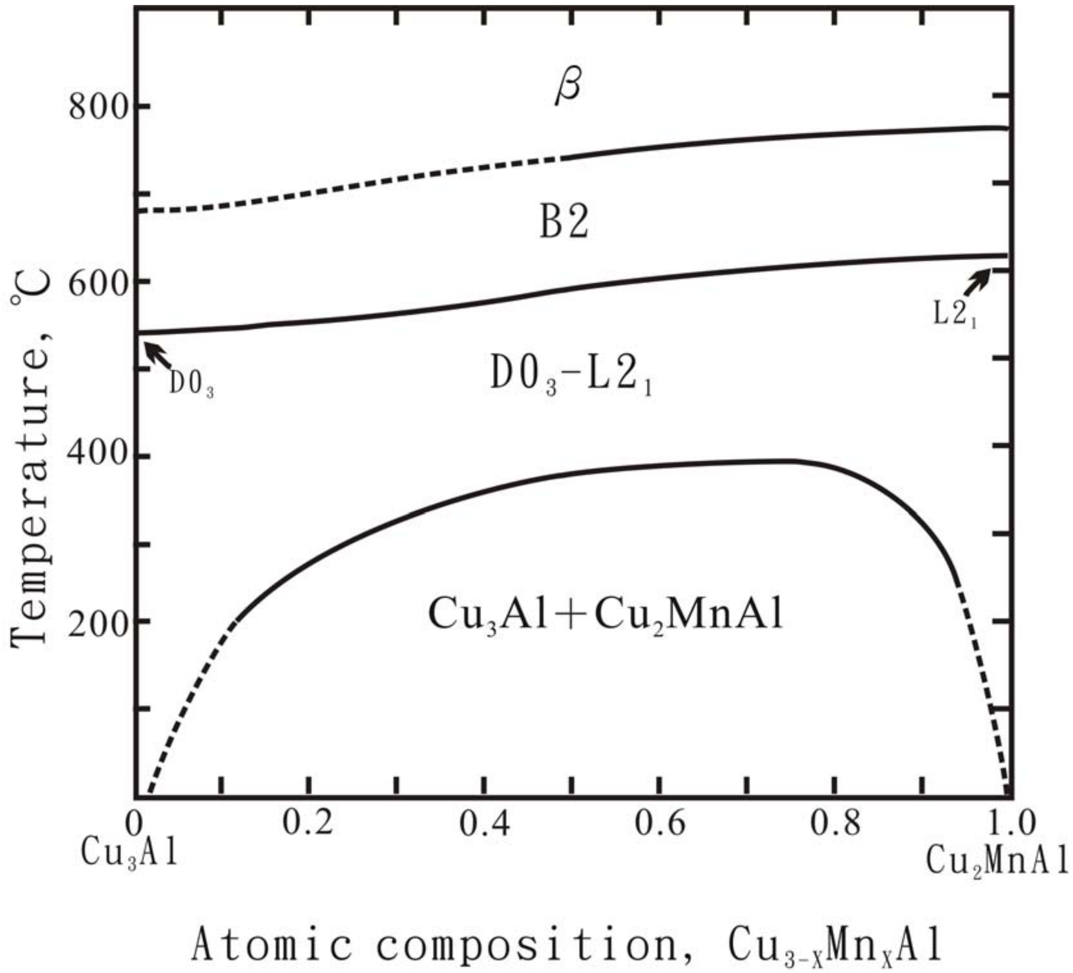


Fig. 1 A schematic drawing of the ordering temperatures Tc (B2) and Tc ($D0_3$+$L2_1$) and the miscibility gap of the $Cu_{3-x}Mn_xAl$ alloy.

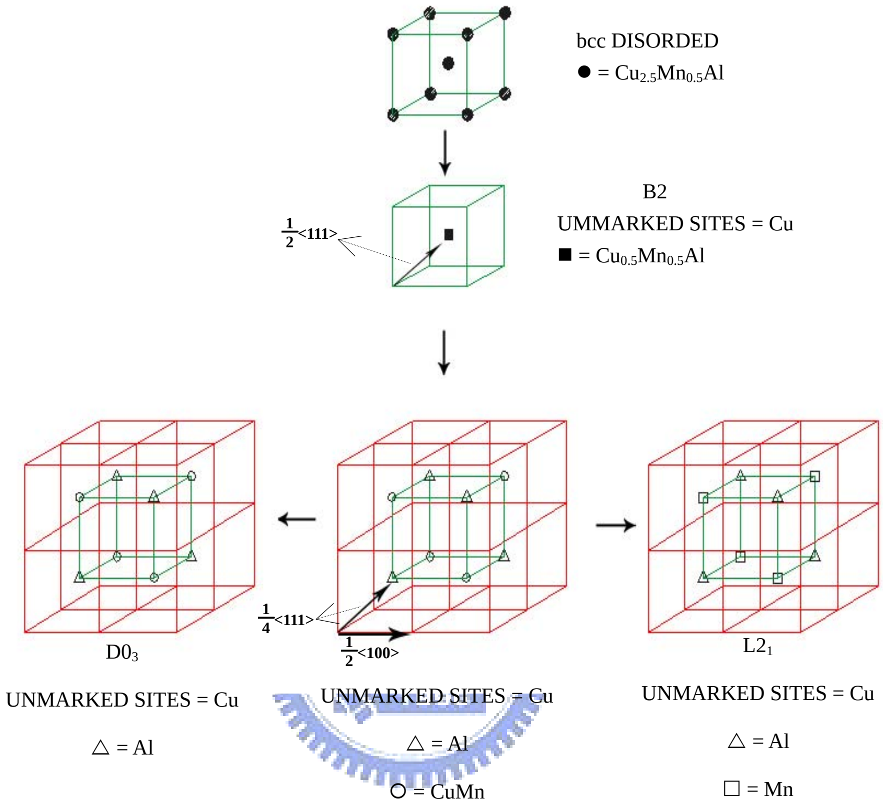


Fig. 2 Schematic representation of the ordering sequence of the quenched $Cu_{2.5}Mn_{0.5}Al$ alloy (vertically) and its isothermal decomposition (horizontally).