Experimental Procedure

(A) Alloy preparation.

Four alloys, $Cu_{2.9}Mn_{0.1}Al$ (alloy A), $Cu_{2.8}Mn_{0.2}Al$ (alloy B), $Cu_{2.7}Mn_{0.3}Al$ (alloy C) and $Cu_{2.6}Mn_{0.4}Al$ (alloy D), were prepared in a vacuum induction furnace under a controlled protective argon atmosphere by using 99.99% copper, 99.9% manganese and 99.99% aluminum. The melts were chill cast into a 30x50x200-mm-copper molds. After being homogenized at 900℃ for 72 hours, the ingots were sectioned into 2-mm-thick slices. These slices were subsequently solution heat-treated at 900℃ for 1 hour (in the single β-phase state) and then quenched into iced brine rapidly. The chemical compositions of the present alloys were analyzed by inductively coupled plasma-mass spectrometer (ICP) and listed in Table 1.

(B) Transmission electron microscopy (TEM)

Electron microscopy specimens were prepared by means of a double-jet electropolisher with an electrolyte of 70% methanol and 30% nitric acid. The polishing temperature was kept in the range from -30℃ to -15℃, and the current density was kept in the range from 3.0x104 to 4.0x104 A/m^2. Electron microscopy was performed on a JEOL JEM-2000FX scanning transmission electron microscope operating at 200 KV. This microscope was equipped with a Link ISIS 300 energy-dispersive X-ray spectrometer (EDS) for chemical analysis.

Table 1. Chemical compositions of the phases revealed by inductively coupled plasma-mass spectrometer (ICP).

		Chemical Composition (at. pct.)		
Alloy	Stoichiometry	Cu	Al	Mn
A	$Cu_{2.9}Mn_{0.1}Al$	72.82	24.36	2.82
B	$Cu_{2.8}Mn_{0.2}Al$	70.45	24.57	4.98
C	$Cu_{2.7}Mn_{0.3}Al$	67.51	24.87	7.62
D	$Cu_{2.6}Mn_{0.4}Al$	65.79	24.48	9.73