Microstructural characterization of Al-Cu alloy with optical microscopy in bright field and polarized light

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Precipitation hardening is characteristic for aluminium-copper (Al-Cu) alloys. Main characteristics of Al-Co alloys, series 2xxx, are: wide range of mechanical properties and reduced corrosion resistance. Corrosion resistance and mechanical properties of the Al alloy, depend on its microstructure. As corrosion resistance properties can be improved by some technological processes, these alloys, because of their high strength, hardness and fatigue failure resistance, have found the application even in the most extreme conditions such as aircraft, vehicles and shipbuilding industries.

In this paper, the effects of homogenization annealing on the microstructure of the hypoeutectic Al-Cu alloys DC cast billets have been explored. Different optical microscopy techniques were used in order to examine and characterize microstructure. Segregations in microstructure causes not only the inhomogeneity of the microstructure, but also creates the locations with different mechanical properties which may degrade material performances. In order to improve material properties, providing homogeneous microstructure was the initial goal. Homogenization was performed at 500°C for a different holding times (3h, 6h, 8h, 10h, 12h, 14h and 16h).

Microstructural changes are visible even after shortest homogenization times and microsegregations are reduced to a large extent during it. Otherwise, results have shown that macrosegregation can not be completely eliminated from the structure even after the longest homogenization times. Intermetalic Al2Cu phase dissolves and remains in the structure only in the traces.

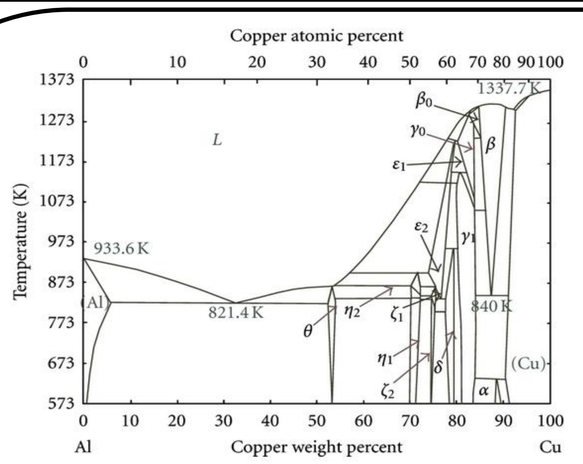
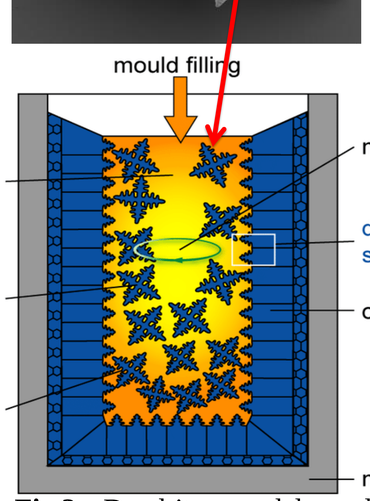


Fig.1 Al-Cu phase diagram



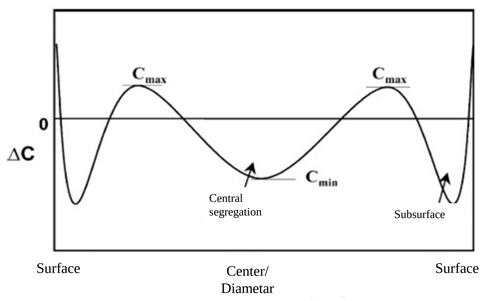


Fig.2 Chemical inhomogenity

Fig.3 Dendrite model and schematic ilustration of solidification in mould

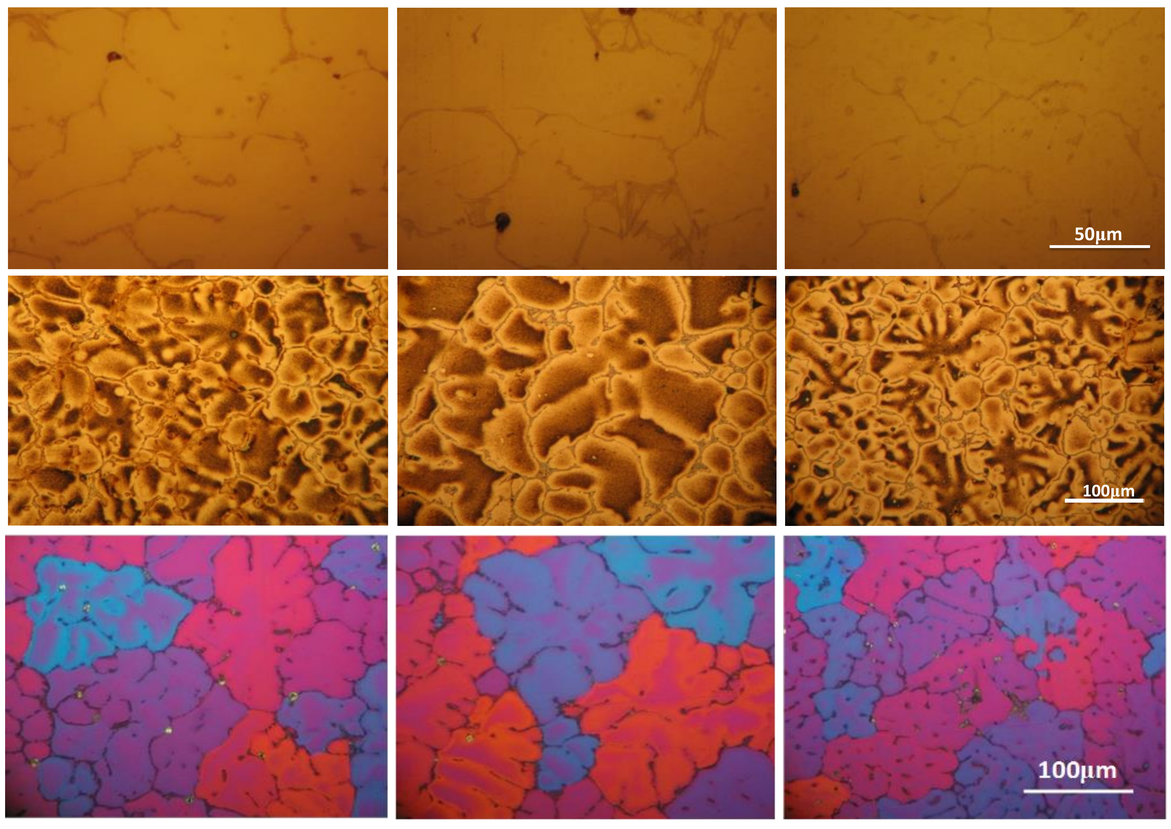


Fig.4 Microstructure of Al5Cu alloy in as cast condition (from surface to the centar of bloom)

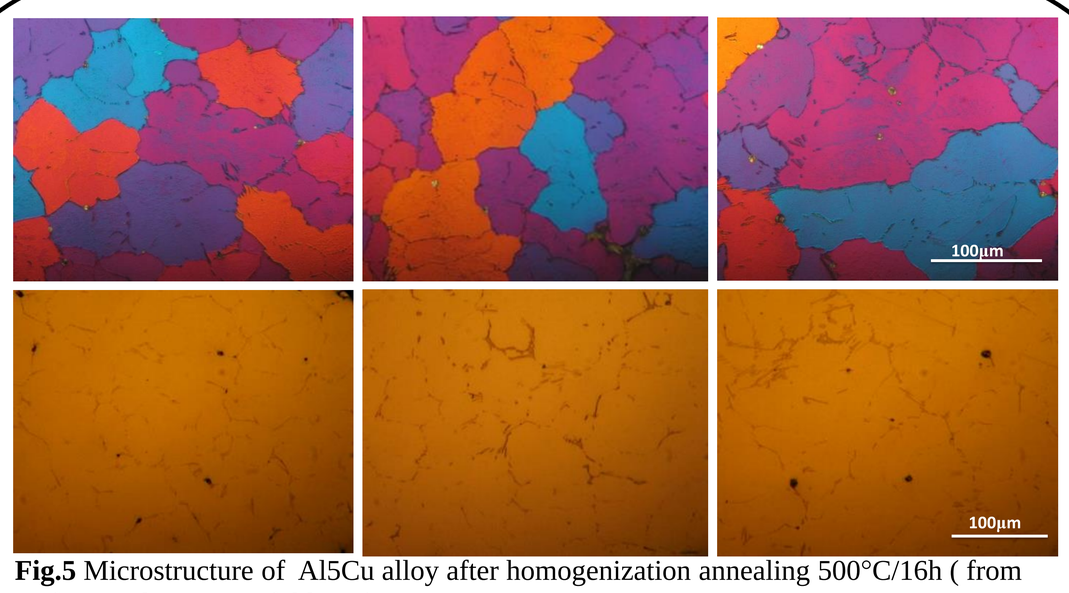


Fig.5 Microstructure of Al5Cu alloy after homogenization annealing 500°C/16h (from surface to the centar of bloom)

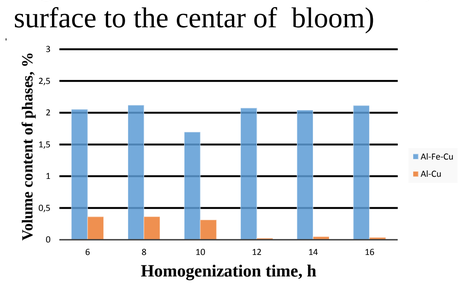


Fig.6 Volume content of intermetalic phases after different homogenization times

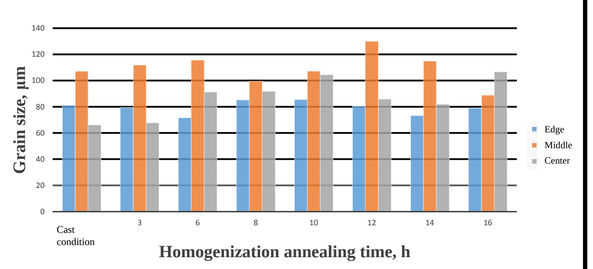


Fig.7 Average grain size in throught blooms after different homogenization times

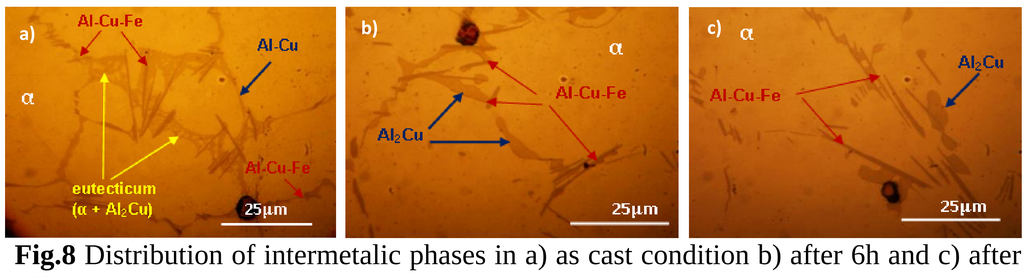


Fig.8 Distribution of intermetalic phases in a) as cast condition b) after 6h and c) after 10h of homogenization

Conslusions

- Visible microstructural changes even after shortest annealing times
- Microsegregations are reduced to a large extent.
- Macrosegregation: Coars Al2Cu dissolves and remains in structure in traces. Needle-like Al7Cu2Fe remains in structure, mostly along the grain boundaries
- Grain size does not change during homogenization

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