PROPERTIES, HOT WORKING AND APPLICATIONS OF CU-AG ALLOYS OBTAINED BY CASTING AND POWDER METALLURGY

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Abstract *In the paper we present in comparison hardness and electrical conductivity of copper cast ingot (I/M) and sintered copper (P/M) with Cu-Ag5 alloys (I/M and P/M) subjected to the same treatment.*

Keywords: *copper, Cu-Ag5 alloy, annealing, hardness, electrical conductivity.*

1. INTRODUCTION

In order to compare some of the properties an ingot of unalloyed Cu and sintered Cu were prepared and subjected in the same time thermomechanical treatment as I/M and P/M [1] $Cu\text{-}Ag_5$ (weight percent) alloys.

We measured hardness (microhardness) and electrical conductivity for the materials already mentioned.

Cu-Ag5 alloys are used for single-girder overhead travelling crane contactors.

Phase equilibrium diagram Cu-Ag with eutectic transformation is shown in figure 1 [2], and microstructure of $Cu\text{-}Ag_5$ alloy is given in figure 2 [3] with interdendritic Ag deposition and copper based solid solution.

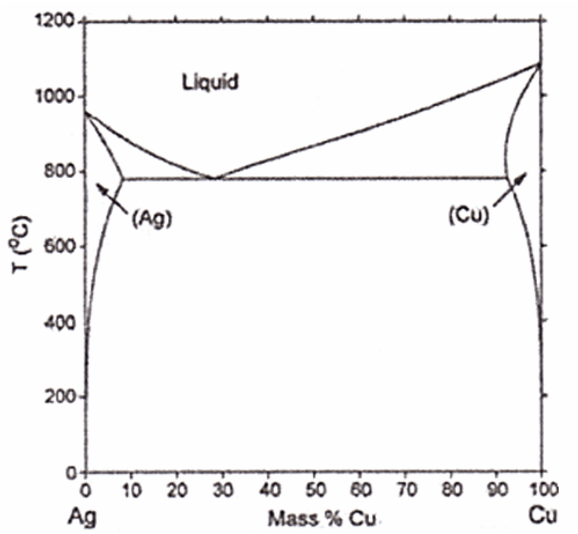

Figure1. Phase equilibrium diagram Cu-Ag.

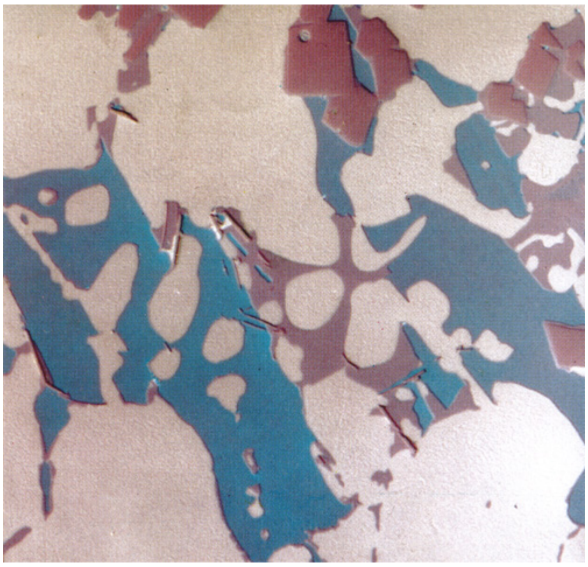

Figure 2. Photomicrograph of $Cu\text{-}Ag_5$ alloy (x 500). Interdendritic Ag deposition and copper base solid solution.

The values of microhardness of I/M and P/M $Cu\text{-}Ag_5$ alloys versus deformation degree is shown in figure 3.

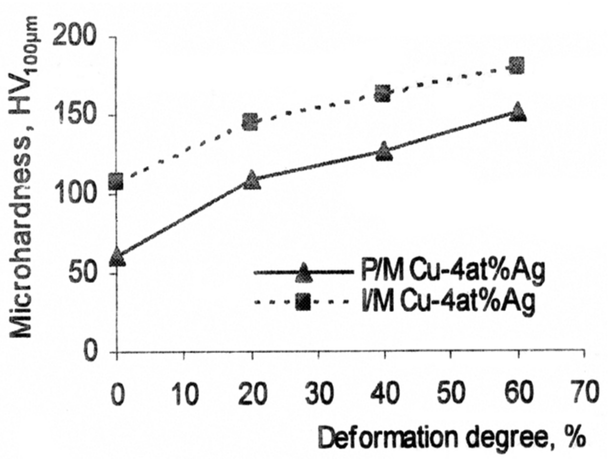

Figure 3. Microhardness of I/M and P/M Cu-Ag_5 alloys versus deformation degree.
I/M – cast (ingot) metallurgy;
P/M – sintered (powder) metallurgy).

The values of electrical conductivity of I/M and P/M copper and of I/M and P/M Cu-Ag_5 versus deformation degree is shown in figure 4.

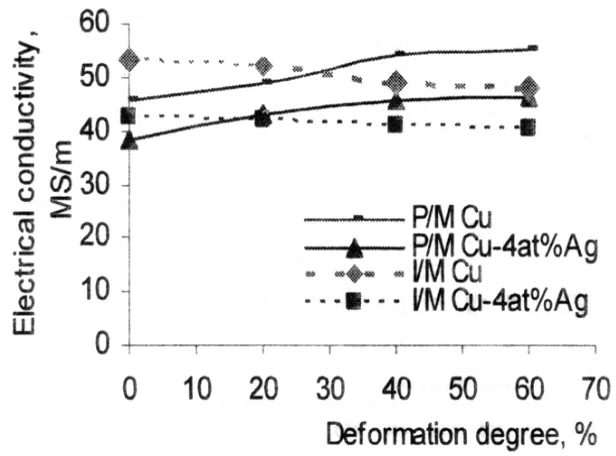

Figure 4. Electrical conductivity of I/M, P/M copper and of I/M, P/M Cu-Ag_5 versus deformation degree.

2. RESULTS AND DISCUSSION

For more Cu based alloys hardness is increased after cold working and annealing recristallization. The strengthening effect is termed anneal hardening and is used for copper alloys for electro-mechanical devices.

The influence of Ag, as a substitutional element, in copper based solid solution is the following: the strengthening increases with substitutional element concentration increasing. In Cu-Ag_5 alloy cold rolling is followed by annealing at 150-400°C.

Cu-Ag_5 alloys were prepared by melting in induction furnace, cast into ingots (I/M) and the cold worked and annealed and starting from powder (Cu and Ag), by powder metallurgy using a hydraulic press, then sintered at 780°C in a furnace with controlled atmosphere and the cold rolled with a deformation degree between 20 to 60%.

Annealing was carried out at 150 to 600°C.

The microhardness of I/M copper and I/M Cu-Ag_5 alloy samples increases with the degree of deformation (50 to 150 μHV) as it can be seen in figure 3.

Electrical conductivity decreases with increasing degree of cold deformation (rolling) for cast (I/M) Cu-Ag_5. In exchange electrical conductivity increases with the degree of cold rolling for sintered (P/M) Cu-Ag5 as it can be seen in figure 4.

During recrystallization, in the temperature range 160°-400°C, for copper (I/M) and (P/M) hardness increases (23 HV to 28 HV), due to anneal hardening effect, hardening is stronger for sintered Cu-Ag_5 alloy than for the cast Cu-Ag_5 alloy (31 HV compared to 27 HV).

3. CONCLUSIONS

Electrical conductivity is a little higher for Cu in comparison with Cu-Ag_5 alloy, because Ag decreases electrical conductivity.

The increase of electrical conductivity during cold rolling depends with the decrease of porosity. However the electrical conductivity decreases after cold-working.

Recrystallization annealing after cold rolling doesn't decrease the hardening effect of Cu-Ag_5 because of Ag segregation on dislocations.

4. REFERENCES

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