

INFLUENCE OF IMPURITIES

WHY DETRIMENTAL

ANNEALING BEHAVIOR
CONFORMABILITY
SPRINGINESS

CONDUCTIVITY
HOT SHORTNESS
WIRE BREAKS

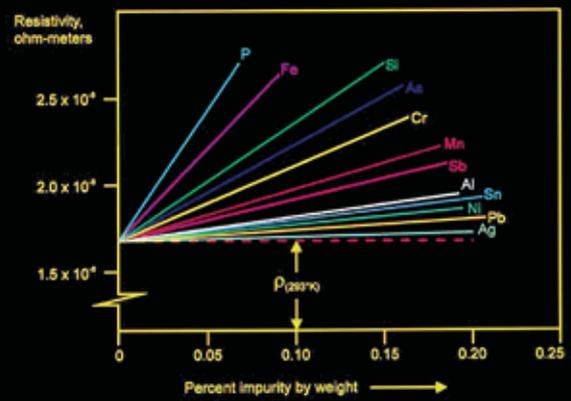
HARMFUL

Se
Te
Bi
S
As
Sb

NOT SO HARMFUL

Fe
Ni
Co
Ag
Zn
Cd

Pb
O



General Influence of Impurities on Copper Conductivity

Effect of Each Possible Impurity on Copper Resistivity

Factors Affecting Electrical Conductivity of Copper

Electrical conductivity is the reciprocal of resistivity. IACS is a calculated number that is obtained by dividing the International Annealed Copper Standard (IACS) value for resistivity at 20 °C by the measured resistivity of the wire at the same temperature. Multiplication of this ratio by 100 produces percent IACS values. Electrical resistance is measured experimentally and it is dependent upon the dimensions (diameter and length). In contrast to resistance, electrical resistivity is an intrinsic property of the conductor and is associated with the ease with which conduction electrons can move through the material under influence of an electric field. There are three major influencers of resistivity, and impurities in the copper are one of the most important since every solute element increases resistivity linearly with increasing concentration. Impurities have their most potent effect when they are dissolved in the copper solid solution, and are less effective when they are present as oxides or intermetallic compounds. The second influencer of ("residual") resistivity is attributed to structural imperfections such as dislocations, which are produced in great numbers during work hardening. Consequently, electrons can travel more easily through the conductor when it is in the annealed condition. Electrical conductivity of cold worked copper can be 3 % lower compared with the same material in its annealed state. Temperature is the third major influencer of resistivity. Since atoms vibrate at all temperatures above 0°K, they increase resistivity by scattering electrons. Because resistivity is strongly influenced by temperature, corrections for temperature must be made if resistance measurements are not conducted at 20 °C.

In accordance with ASTM specifications B 49 and B 193, "Test Method for Resistivity of Electrical Conductor Materials", resistance measurements may be performed on finished copper rod. However, in case of dispute, the rod is to be cleaned and processed to a diameter of ~ 2 mm, and then annealed for 30 minutes at 500 °C. Other equivalent annealing methods may be used. When performing conductivity calculations, the copper resistivity standard value that is currently in use and was established by the International Electrochemical Commission (IEC) in 1913, corresponds to 100 % IACS. Since copper purity has improved significantly since that time, commercial coppers have conductivities approaching 102 % IACS. Only silver has higher conductivity, namely, 106 % IACS. *by H. Pops*