

Microstructures

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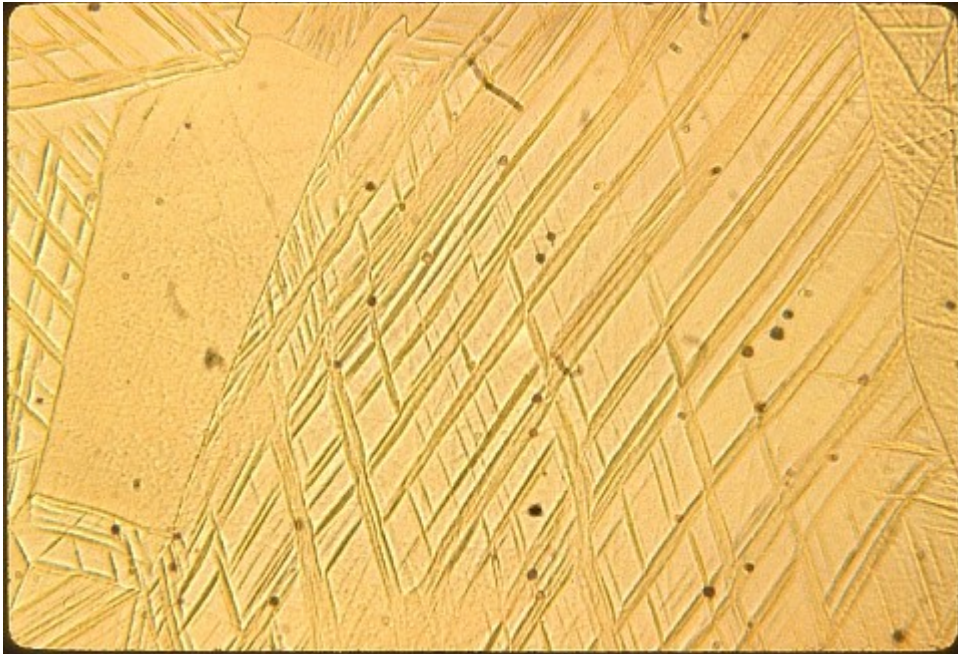
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Non Ferrous Alloys - Lesson 1 - Seventh specimen



This is a phosphor bronze, shown at 200X at left and at 500X below. Phosphor bronze is copper that has been deoxidized with phosphorus. It is much harder and stronger than pure copper, because of the unconsumed phosphorus.

The microstructure consists of cold-worked alpha. Notice the sytrain markings, equiaxed structure, and annealing twins. There are also some deformation twins, which appear needle-like and intersecting. They are actually disk shaped in three dimensions.



Note that the deformation twins "pinch off" where they meet grain boundaries or other twins. That is due to the shear strain involved in the deformation-twinning process, which can't easily occur next to structural discontinuities such as internal boundaries. The annealing twins are evidence of cold work prior to annealing. Cast copper microstructures cannot contain such annealing twins. The annealing twins seen here have been bent; therefore, the specimen has been cold worked again after the annealing was completed.

STACKING SEQUENCES IN FCC CRYSTALS

A. NORMAL FCC LATTICE

A B C A B C A B C

B. SINGLE DEFORMATION FAULT

A B C A B C
C A B C

C. DOUBLE DEFORMATION FAULT

A B C A B C
B C A B C
A B C A B C

D. TWIN FAULT

B C A B C
A B C A B C

NOTE: DEF. TWINS REQUIRE MULTIPLE SUPERPOSITION OF DEFORMATION FAULTS.
ANNEALING TWINS CAN OCCUR WHEN SINGLE DEF. FAULTS ARE INCORPORATED INTO THE NEW GRAINS AS THEY GROW.

The stacking sequences possible in an imperfect face centered cubic (FCC) structure explain the origin of annealing twins. Dislocations in FCC metals are split into pairs of imperfect "partial" dislocations separated by a band of stacking fault (deformation fault).

Deformation introduces many stacking faults (the more, the lower the interfacial energy of the stacking fault). These stacking faults subsequently induce annealing twins to form during recrystallization of the cold worked metal.

Specimen 8 shows that [damage can happen during annealing of a cold worked structure.](#)