Ph 381 lab

metallography and micro-hardness testing of an American cent

Purposes: to gain an insight on how metallography is done

to do a simple experiment how cold rolling changes the microstructure of the cent

to do a simple experiment how a heat treatment of a cold rolled cent changes its microstructure

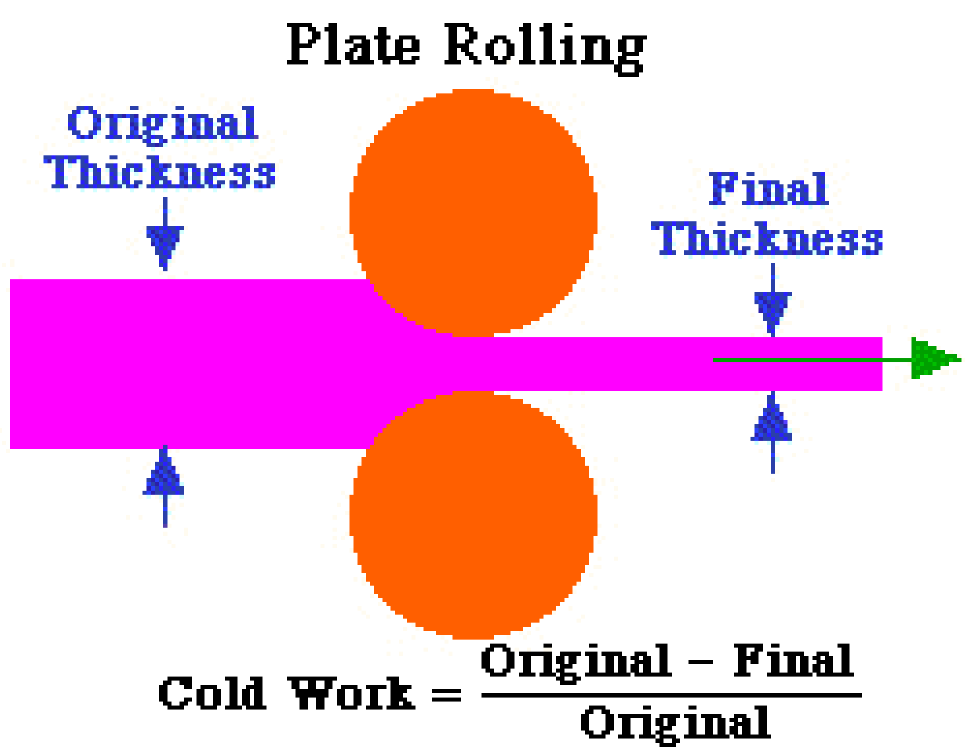
to notice the difference in microstructure parallel and perpendicular to the growth direction

to notice the difference in microstructure that result from the heat treatment

to determine micro-hardnesses for all processing conditions
(sectioned parallel and perpendicular to rolling direction for both as cold-rolled and annealed samples)

to determine the nature of the alloy the cent is made of by means of energy dispersive X-ray spectroscopy in a Scanning Electron Microscope (SEM)

to clean surfaces and see grain boundaries imaged in a Focused Ion Beam microscope



actions:

cold roll an American cent to a thickness of below about 1 mm, i.e. cold work it to ˜ 30 %

section parallel and perpendicular to the rolling direction, i.e. cut into 4 pieces

anneal one pair of samples “parallel and perpendicular to the rolling direction” at 370 ºC for 1 hour, i.e. 600 ºF at the reading of oven I

embed the two samples (cold-rolled and annealed) that were sectioned perpendicular to the cold-rolling direction in SAMPL-KWICK

embed the two sample (cold-rolled and annealed) that were sectioned parallel to the cold-rolling direction in (conductive) KONDUCTOMET for later analysis in SEM

grind and polish all four samples

etch the SAMPL-KWICK embedded samples gently with a mixture of 5 ml HNO_3 to 100 ml H_20

observe the microstructure of these two samples under the light microscope,

observe the microstructure of the KONDUCTOMET embedded samples (prior to etching) under the SEM and FIB

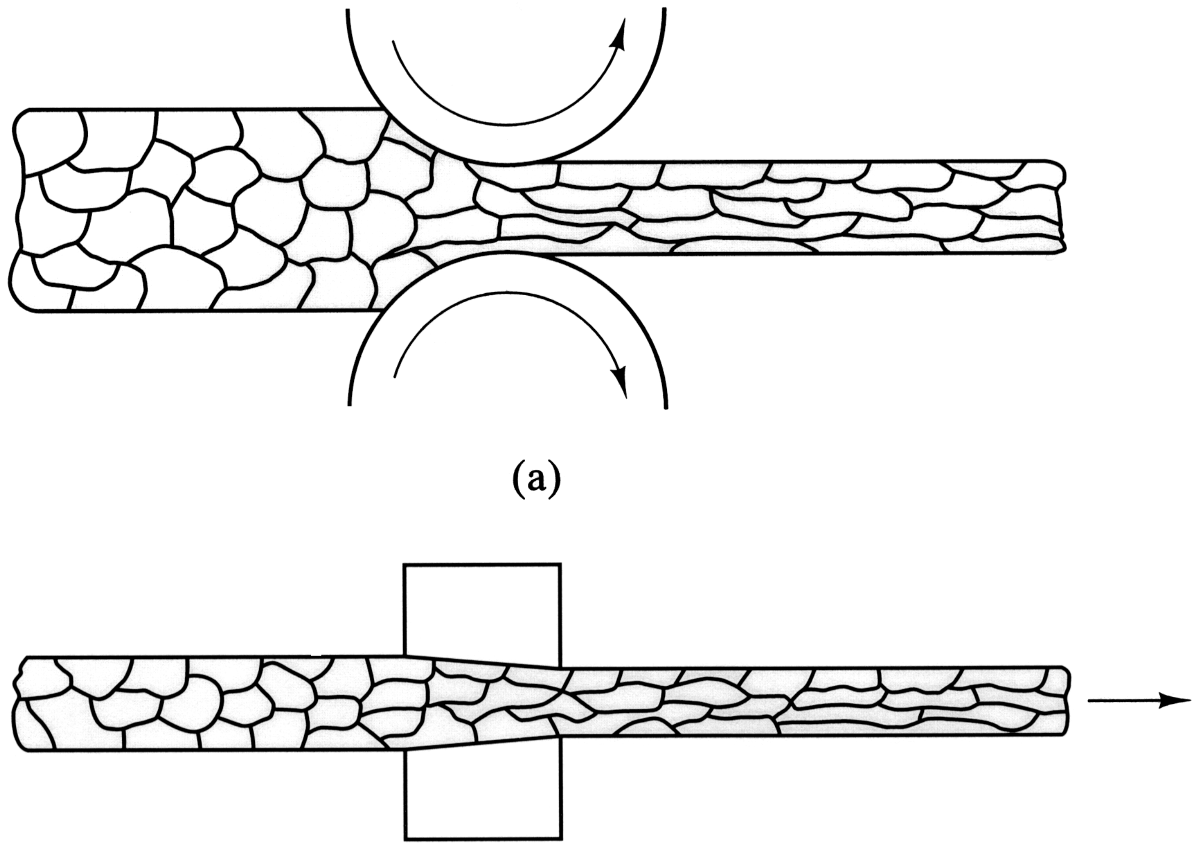
etch the KONDUCTOMET embedded samples gently with a mixture of 5 ml HNO_3 to 100 ml H_20 and observe the microstructure of these samples (after etching) under the light microscope, SEM and FIB

determine the typical grain size and shape in all four specimen, determine the micro-hardnesses for all four specimen, and search for a reasonably accurate qualitative model that can explain your experimental observations

Students: Do take notes on important observations, comments by the teaching assistants, and the final results! Several questions that you shall be able to answer if you are attentive during the laboratory sessions and study at home for qualitative explanations will be asked off you in your weekly homeworks, 3 tests and the final exam!

You should also use one of the text recommended in the syllabus for this little research project.

The following sketches and figures may help you in your quest for qualitative explanations for your observations.



(a)

(b)

Figure 10-29 *Examples of cold-working operations: (a) cold-rolling of a bar or sheet and (b) cold-drawing a wire. Note in these schematic illustrations that the reduction in area caused by the cold-working operation is associated with a preferred orientation of the grain structure.*

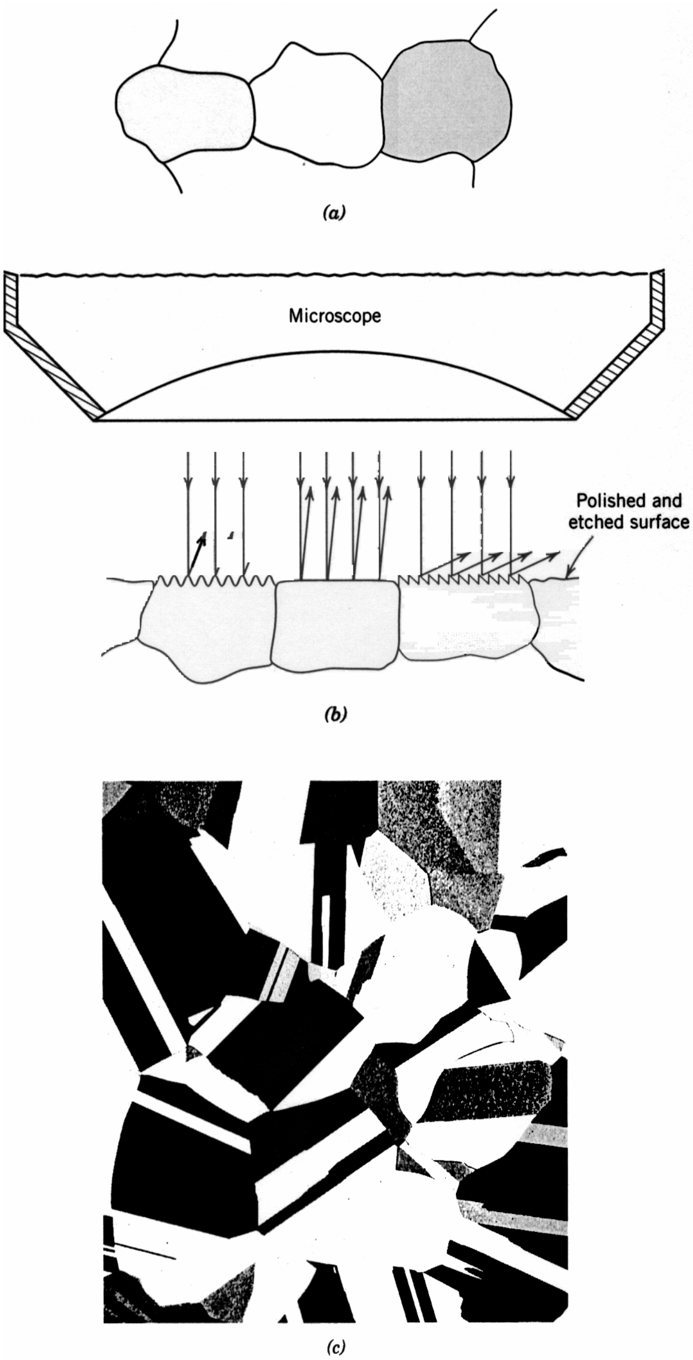


FIGURE 4.11
(*a*) Polished and etched grains as they might appear when viewed with an optical microscope. (*b*) Section taken through these grains showing how the etching characteristics and resulting surface texture vary from grain to grain because of differences in crystallographic orientation.
(*c*) Photomicrograph of a polycrystalline brass specimen. 60×. (Photomicrograph courtesy of J. E. Burke, General Electric Co.)

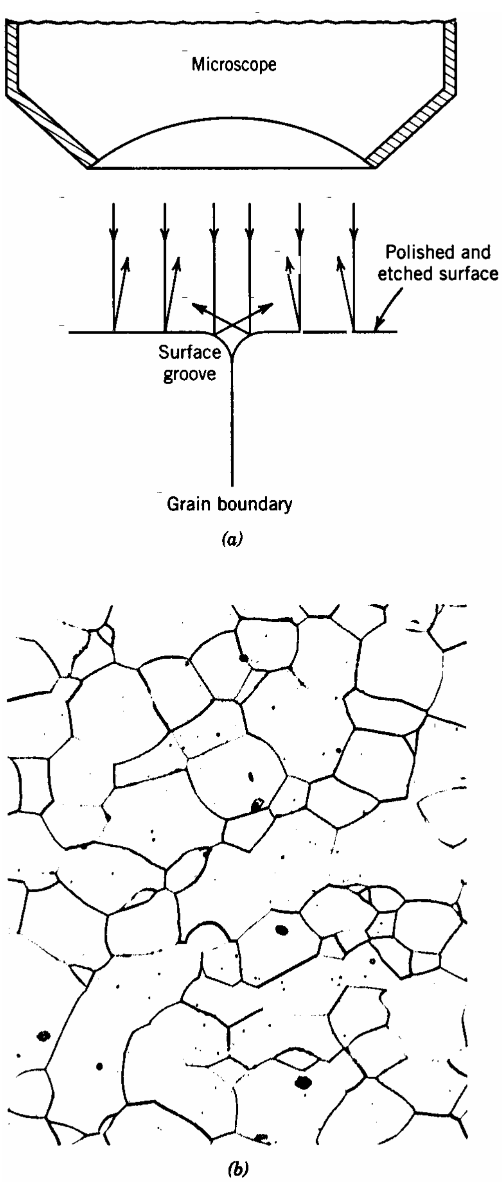


FIGURE 4.12 (*a*) Section of a grain boundary and its surface groove produced by etching; the light reflection characteristics in the vicinity of the groove are also shown. (*b*) Photomicrograph of the surface of a polished and etched polycrystalline specimen of an iron-chromium alloy in which the grain boundaries appear dark. 100×. [Photomicrograph courtesy of L. C. Smith and C. Brady, the National Bureau of Standards, Washington, DC (now the National Institute of Standards and Technology, Gaithersburg, MD.)]

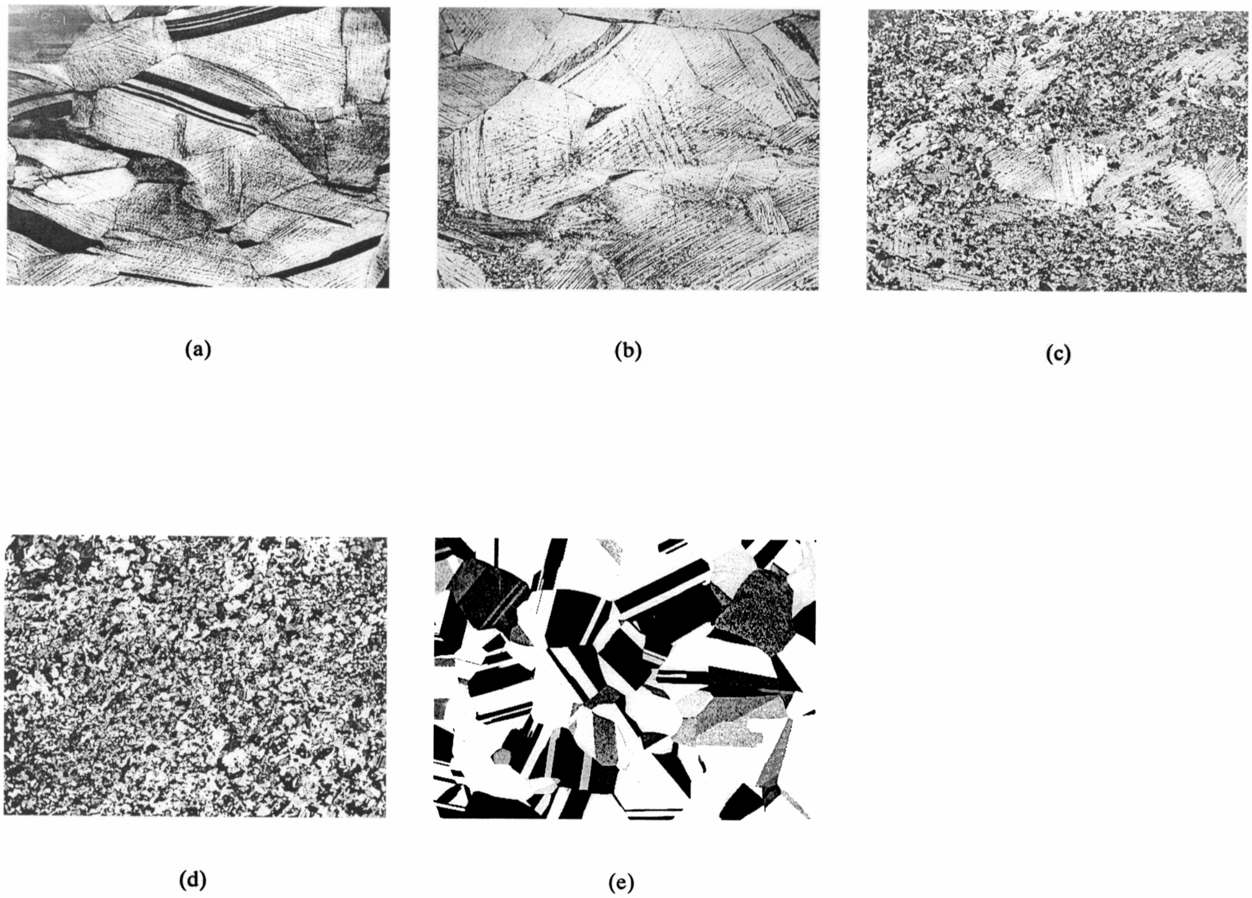


Figure 10-30 *Annealing can involve the complete recrystallization and subsequent grain growth of a cold-worked microstructure. (a) A cold-worked brass (deformed through rollers such that the cross-sectional area of the part was reduced by one-third). (b) After 3 s at 580° C, new grains appear. (c) After 4 s at 580° C, many more new grains are present. (d) After 8 s at 580° C, complete recrystallization has occurred. (e) After 1 h at 580° C, substantial grain growth has occurred. The driving force for this is the reduction of high-energy grain boundaries. The predominant reduction in hardness for this overall process had occurred by step (d). All micrographs at magnification of 75×. (Courtesy of J. E. Burke, General Electric Company, Schenectady, N.Y.)*

The following three figures show the influence of the amount of deformation on the grain structure of aluminum alloy 1100, (a) the starting microstructure, (b) after 25% reduction by cold rolling, and (c) after 50% reduction by cold rolling. The cold-rolling deformation process elongates the grains in the rolling direction and reduces them in the transverse direction.

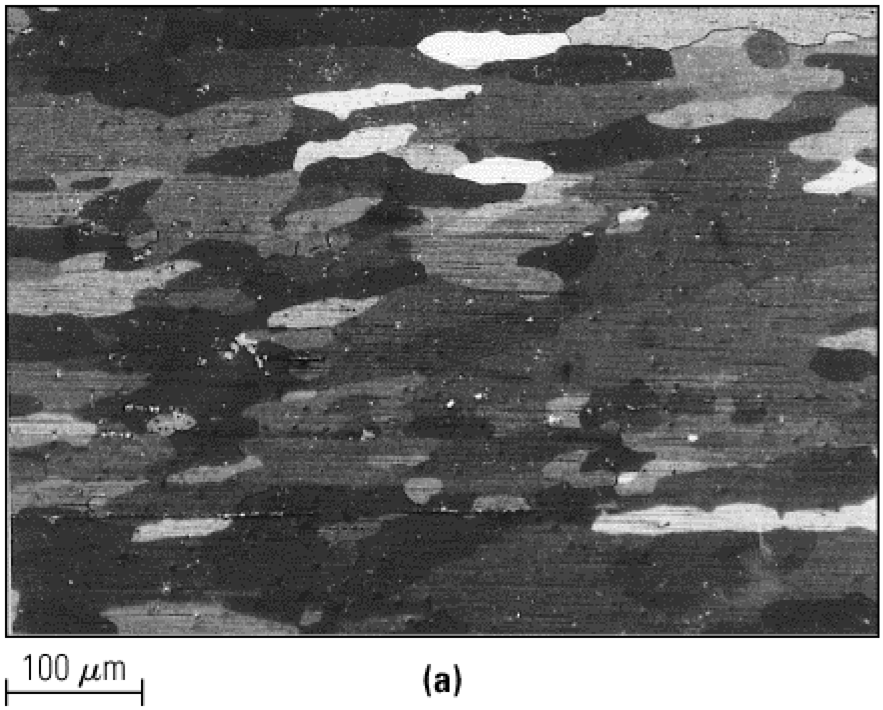
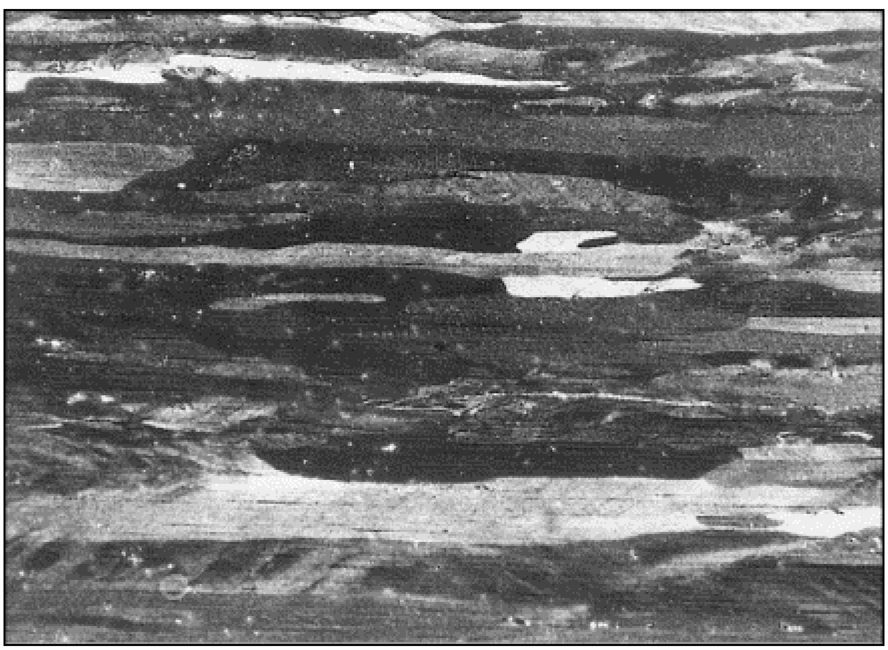


Figure 8.3.29a

(b)

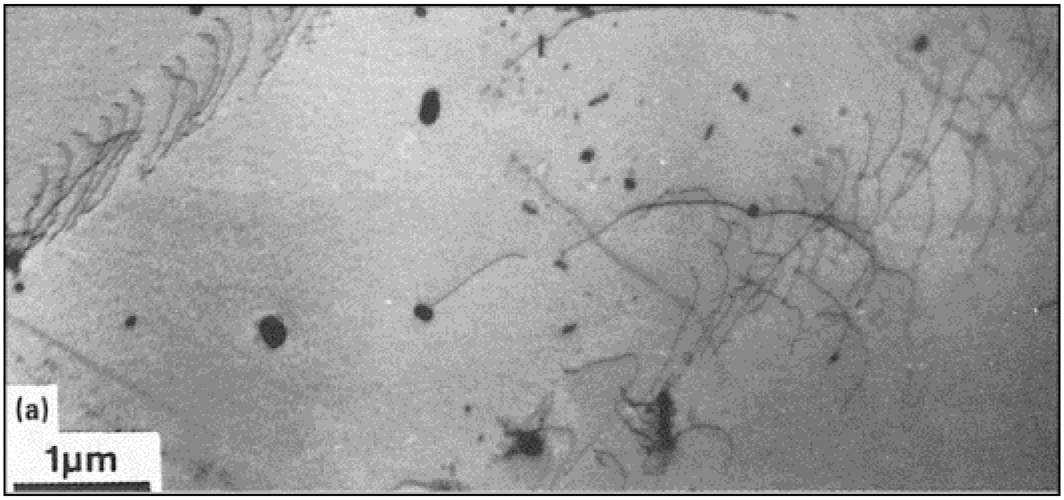
Figure 8.3.29b



(c)

Figure 8.3.29c

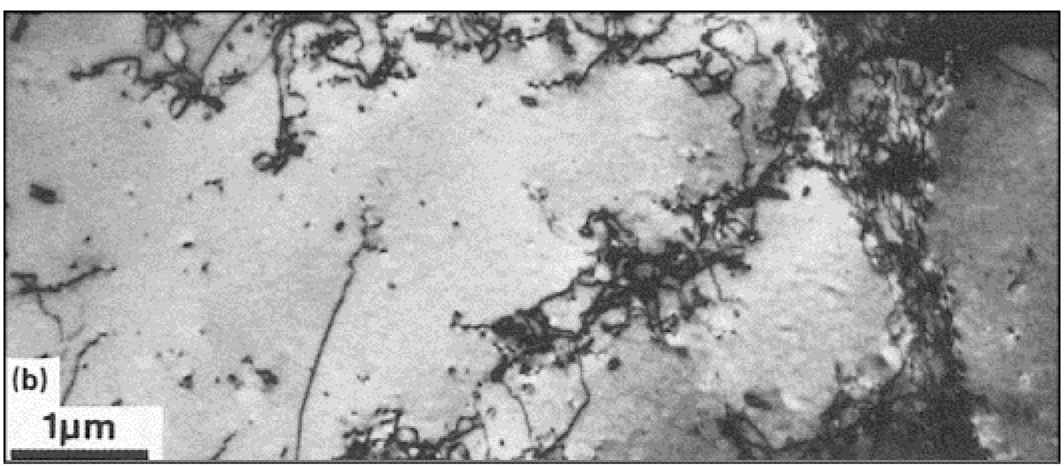
The following three figures are Transmission electron micrographs that illustrate and increase in dislocation density in aluminum alloy 1100, (a) the starting material, (b) after 25% reduction by cold rolling, and (c) after 50% reduction by cold rolling.



(a)

Figure 8.3.30a

t/a Schaffer: The Science and Design of Engineering Materials, 2/e



(b)

Figure 8.3.30b

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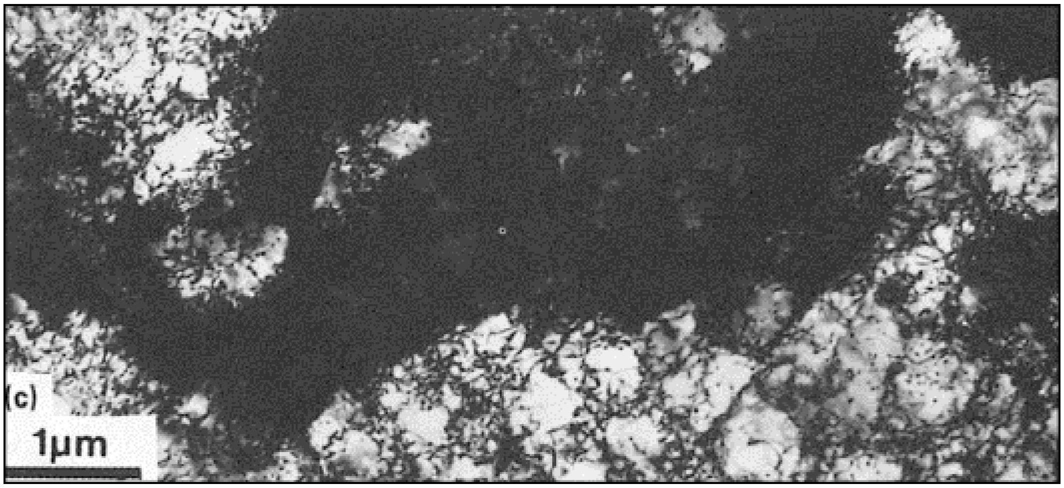

(c)

Figure 8.3.30c

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