

Work Hard Engineering
University of Portland
Portland, Oregon 97203
(503) 943-7432

February 8, 2016

Students
Materials Science Laboratory
5000 N. Willamette Blvd.
Portland, OR 97203

Dear Students,

In order to learn more about the basic behavior of commercially pure copper I am requesting you conduct testing on the specimens I have provided you. I would like to understand the effect of cold working on hardness. I would also like to know the effect of annealing on the hardness of the cold rolled specimens. Please conduct the testing you believe to be appropriate for collecting the data. When conducting hardness tests, please be sure to follow *ASTME E18 - Standard Test Methods for Rockwell Hardness of Metallic Materials*.

Each student is to complete the attached worksheet (on the backside of this letter).

In addition to the work associated with this laboratory (which each student is responsible for completing), please continue working on your Independent Laboratory. You are to submit (as a team) the draft plan for your experiment and revise the background if so advised. See the course web page for details.

If you have any questions, please do not hesitate to contact me at 503-943-7432 or lulay@up.edu. Thank you.

Sincerely,
(*electronic*)

Kenneth Lulay
UP Engineering

Enclosed: Two (2) pieces of commercially pure copper
Worksheet

Worksheet for cold-rolling and annealing of copper.

All work is to be either clearly hand written or typed using 12 point Times New Roman font. Do not go by memory, please use a materials science texts (textbook, ASM Handbooks, etc.) and provide bibliography information for sources used (including page numbers).

- 1) Present the results (i.e. make graphs) from this lab in a format consistent with using them in a report or technical letter (including figure number and caption). Be sure to *think carefully* about what you want to communicate and how to *best communicate* the results. The graph (as all graphs) should be “stand alone” – the reader should be able to understand the graph and what you are trying to communicate through it by the graph and its caption alone. Use the “graphing checklist” (posted on the course web page) and attach it to the FRONT of this assignment. Also attach the original data sheet to the back of this assignment.

If you were to write a technical letter for this lab (you are NOT asked to do so), the background would likely include discussion similar to questions 2 through 4 and 6.

- 2) Describe the processes of recovery, recrystallization and grain growth. What is changing in the copper microstructure and how does that affect the properties?
- 3) What is/are the changes that result in an increase in hardness as a result of cold working? In other words, why do materials such as copper become harder as they are cold worked? Is there an “upper limit” to how hard copper can become as a result of cold working (or will it continue to get harder and harder and harder...)?
- 4) What is/are the changes that result in a decrease in hardness as a result of annealing? In other words, why does annealing decrease the hardness of cold rolled copper? Is there an “lower limit” to how soft copper can become as a result of annealing (or will it continue to get softer and softer and softer...)?
- 5) We did not measure strength, toughness or ductility so it would inappropriate to reach a conclusion about these properties. However, speculate about what likely does happens to these three properties as a result of cold working. Should they increase, decrease or not change?
- 6) What is the “rule of thumb” describing the temperature at which recrystallization occurs in metals? Using the “rule of thumb” what temperature should it occur at in commercially pure copper? Show your work. Don’t forget to use the appropriate temperature scale (hint, not Celsius nor Fahrenheit).