UNIVERISTY OF ILLINOIS

College of Engineering

Department of Materials Science and Engineering

Spring 2022, MSE404 Metals Processing

Instructor: Marie-Agathe Charpagne

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Teaching Assistants:

TBD

Lab Supervisor: Nicole Robards

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Location: 112 Ceramics building

Sessions: 01/18/2022-03/10/2022, MW 2:00-4:50PM (MP1) or TR 2:00-4:50PM (MP2)

Office Hours: Fridays 1-4PM.

Course Objectives:

1. Learn specific principles of metals processing through laboratory investigation and, equally important, to learn proper experimentation, proper use of instruments, and respect for safety.
2. Develop written, graphical, and oral communication skills that are essential to a clear presentation of your finings and a persuasive presentation of your thoughts.
3. Practice organization of large bodies of material into logical, concise, and accurate reports.

Overview

Experiment I: Establishing the TTT diagram of a steel

TTT diagrams are essentials tools to the design of heat treatments of multi-phase alloys. In this experiment, you will perform heat treatments, perform metallography and optical microscopy, SEM and hardness measurements to construct the TTT curve for a medium alloy steel (grade 4340).

Experiment II: Rolling and recrystallization textures of Brass

Control of the crystallographic texture and recrystallization processes are essential during processing of metals. In this experiment, you will cold-roll a bar of brass, then heat-treat it and quantify its recovery, recrystallization, grain growth and texture evolution using optical microscopy, XRD and hardness measurements.

Experiment III: Design of an ageing heat treatment in a Nickel base superalloy

Ageing is a classic heat treatment generally performed at the very end of most manufacturing processes in precipitation-strengthened alloys. You will investigate the effect of ageing time and temperature on the mechanical properties of a Nickel base superalloy. Several ageing conditions will be tried out to find the combination of temperature and time that gives the highest yield strength. Deformed samples will then be polished, etched and examined in the scanning electron microscope to characterize the size and volume fraction of precipitates for correlation of the macroscopic mechanical properties with the strengthening mechanisms (precipitate cutting, Orowan looping). The contribution of the precipitates to the alloy's strength will be evaluated analytically.

Plan: Each laboratory will be performed over five sessions with two sessions per week (MW or TR 2:00-4:50, see calendar). All experiments will be performed in groups of 2 to 3 (Ceramics building).

Assignments and Grading:

1. The overall grade will be split equally between the three experiments.
2. Pre-lab quizzes will be due on your first day of lab. Quizzes represent 15% of grade.
3. A key aspect of this class is not just analyzing data and writing a report, but also learning laboratory procedures for conducting experiments and characterization. Therefore, 25% of the grade will consist of a laboratory comprehension assignment. These assignments are designed to stimulate student questions and should be straightforward to complete if you have attended the lectures and read the lab manual. These will be de on the last day of each lab.
4. Lab reports will be due one week after the conclusion of the lab. Each student will turn his/her own lab report. Discussion with class members is fine but writing and figures making will be individual efforts. Criterial for individual reports will be listed on the lab manual. Reports will make up 60% of the grade.
5. Late assignments will be accepted up to 3 days after the due date with a flat of 20% reduction in score applied. Pre-labs and lab comprehension assignments will not be accepted after this. Lab reports turned in later than this will be accepted but incur a 50% reduction in score. Your grade in the class will be marked incomplete if any lab reports are not turned in by the end of the semester.

6. Final letter grades will be awarded depending on the class average and relative performance of the individual. An overall score of less than 40% will be considered a failing grade. The instructor reserves the right to adjust borderline grades (up to 3% of the final grade) based on student conduct.

Calendar

Experiment	Dates MP1	Dates MP2	Prelab Due	Lab Report Due
I	01/19 (lecture+lab) 01/24 (lab) 01/26 (lab) 01/31 (lab) 02/02 (lab+report)	01/18 (lecture+lab) 01/25 (lab) 01/27 (lab) 02/01 (lab) 02/03 (lab+report)	01/19 (MP1) 01/18 (MP2)	02/09 (MP1) 02/10 (MP2)
II	02/07 (lecture+lab) 02/09 (lab) 02/14 (lab) 02/16 (lab) 02/21 (lab+report)	02/08 (lecture+lab) 02/10 (lab) 02/15 (lab) 02/17 (lab) 02/22 (lab+report)	02/07 (MP1) 02/08 (MP2)	02/28 (MP1) 03/01 (MP2)
III	02/23 (lecture+lab) 02/28 (lab) 03/02 (lab) 03/07 (lab) 03/09 (lab+report)	02/24 (lecture+lab) 03/01 (lab) 03/03 (lab) 03/08 (lab) 03/10 (lab+report)	02/23 (MP1) 02/24 (MP2)	03/09 (MP1) 03/10 (MP2)

Resources

Compass: references, notes, lab handouts and assignments will be posted there. Turn in assignments and see grades there.

Piazza: For all questions and discussions.

Reports

A substantial fraction of the grade in MatSE 404 will be determined by your reporting skills. It has been shown that learning through writing and speaking can be substantial and long-lasting. Moreover, it provides a simple means for evaluating your performance. A writer or speaker is not born "good", and one of the objectives of this course is to improve your writing and speaking skills. The final words are only part of the reporting experience. Not only grammatical skill, but also organization, background research, judgement of relevance, a clear idea of the message to be transmitted, logical sequencing and motivation of the reader or listener are all important parts of a successful report. Of course, thoughtful, accurate and complete observations and data-taking must be the basis of any good lab report. Review the following format guidelines or see the format guide and example figures files on Compass.

1. The length should be a **maximum of 8 pages including primary figures**. Be concise! Supplementary figures, tables and such can be attached as an appendix.
2. The text should be written in **sections,** each with a label.
3. The style should be informative but not tutorial; you should assume the reader knows the subject at least as well as you but does not know the details of what you have done or the results. Thus, you must include the *uncertainties* in the measurements and draw conclusions. You should include an outline of the experiment or test and your method of analysis. Give a brief background to motivate your investigation, but there is no need for a thorough literature review.
4. The style of writing should be **formal**. This means:
    - Entire report written in 3rd person
    - Experimental section written in the past tense
    - Proper English
5. Figures: All micrographs must have a clearly legible scale marker. Arrows and labels may be used to point out specific features you wish to discuss. Any text on a figure must be clearly legible. Carefully consider the best way to present large/multiple sets of data so that they can easily be understood by the reader.
6. Captions: All figures, tables, and graphs should be labeled and have an appropriate caption. You can then refer to the figures in the text. i.e., "Carbides form on the boundaries due to heating at 500 ˚C, as shown in Figure 1." Captions can be of any length. An example figure is shown below.

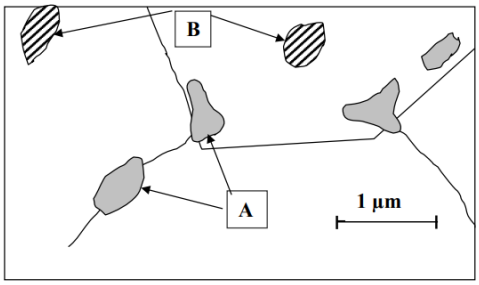

Figure 1. 1040 steel showing sensitization of the grain boundary structure. **(A)** MnC carbides formed on grain boundaries and **(B)** undissolved MnC still within the grains.