Report Writing Guidelines and Tips

Dept. of Materials and Metallurgical Engineering

Key Elements of a Written Report

1) Organization – Tell the story!
2) High quality tables and figures
3) Proper use of numbers/calculations
4) Proper grammar/tense
5) Concise, Consistent

Organization - Sections

- Executive Summary
- Table of Contents
- Introduction/Background - Problem statement, Requirements
- Approach
- Results of experiments/tasks
- Discussion of context (Comparison to other studies, Environmental, Global, and Safety Impact)
- Conclusion
- Future Work
- References
- Appendices
- Acknowledgements

Summary

The purpose of this experiment is to test the process of cold rolling C36000 Brass and C11000 Copper and record the hardness after each pass through the rolling machine. The initial samples will be measured for thickness then tested for hardness by using the Rockwell Hardness Scale. The Rockwell Hardness Scale will use a small indenter to press into the metal using the force of a set counterweight. This data is to be recorded before rolling. The sample will then be sent through a rolling machine set to press the metal to be roughly one hundredth of an inch thinner than before it passes through the machine. The process is repeated and the thickness and hardness are recorded for each repetition. These hardness values will be converted from the Rockwell Hardness Scale to the Vicker's Hardness Scale, and strain hardening coefficients will be determined for both the brass and copper samples. The data will then be compiled into a thickness vs. hardness graph and will also contain a power law fit line.

Summary

- Purpose – stand alone
- Function
  - State topic
  - Describe approach
  - **Summarize major findings outcomes**
- Common mistakes
  - Not stand alone
  - Describing what will be done
  - Failing to include actual numbers – be specific

Introduction/Background

- Purpose - give pertinent information for motivation of the study
  - Problem: Technical issues
  - Customer
  - Constraints
  - Objectives
  - Related studies – literature review
- Common Mistakes
  - Irrelevant information
  - Information is too general
  - Plagiarism

Approach/Methodology

- Restate the problem to describe how the work was done
- Describe the design approach
  - What are the big steps?
  - What are the sub-tasks needed
  - Decision methods/process
  - Materials, equipment used

Results

Three separate materials are tested: hot rolled 1018 steel, brass 260 alloy, and 6061-T651 aluminum. The results show steel to have the highest modulus of elasticity of 24,500 ksi, the highest yield strength of 53.5 ksi, the highest tensile strength of 71.5 ksi, the highest toughness of 24.3 ksi, a similar percent elongation to brass of 34.2 % which is much higher than the percent elongation of aluminum, and a strain hardening coefficient of 0.09. The brass sample had mechanical properties that primarily fell in between steel and aluminum. Brass has an elastic modulus of 13,700 ksi, a yield strength of 49.7 ksi, a tensile strength of 58.2 ksi, a toughness of 19.3 ksi, the highest percent elongation of 34.25 % and a strain hardening coefficient of 0.02. The results for aluminum may be subject to error because the sample fractured at the very edge of the gauge length. Aluminum exhibits the lowest elastic modulus of 9,100 ksi, the lowest yield strength of 40.9 ksi, the lowest ultimate strength of 43.1 ksi, the lowest percent elongation of 8.5 %, the lowest toughness of 5.6 ksi, and a strain hardening coefficient of .004.

How to improve?

Table 1: Rockwell B and Converted Vickers Hardness Values for Copper Roll Tests

	Roll 0	Roll 1	Roll 2	Roll 3	Roll 4	Roll 5	Roll 6
Thickness (in)	0.2495	0.247	0.233	0.2155	0.2	0.183	0.163
Hardness Measurements (RHB)	19, 22, 20	52, 47, 39	67, 69, 69	80, 80, 80	82, 82, 82	86, 86, 86	88, 88, 88
Average Hardness (RHB, rounded to nearest whole number[1])	20	46	68	80	82	86	88
Vickers Hardness[2]	80	102	131	160	166	181	190
% Reduction of Area[3]	0.4	1.2	6.8	13.8	20	26.8	34.8

<u>Strain-Hardening Coefficient</u>

Class data of the copper and brass were compiled, graphed, and analyzed. Figure 1 displays hardness over %RA. The line of best fit via powers method was found to be

$$y = 3 \times 10^{-5}\, x^{2.9973} \quad . \qquad \text{(Eq. 2)}$$

Results

- Purpose – present data (Usually very Short)
  - Relevant theory/equations
  - Experimental results
  - Results of tasks/subtasks

- Common Mistakes
  - Data dump
  - Not describing what is important from figures/tables
  - Inefficient use of text (use figures and tables instead)
  - Improper formatting of tables and figures
  - Intermingling Results and Discussion

Discussion

- Discuss trends
- **Refer back to introductory material (loop back)**
- Discuss potential problems / difficulties (sources of error)
- What are the lessons learned
- Answer questions you anticipate from the reader
- Common Mistakes
  - Listing the answers to questions
  - Not addressing your own uncertainties or items that need additional explanation

Conclusion

- Summarize
  - Most important trends and lessons learned
  - Loop back to original goal

- Common Mistakes
  - “We learned a lot……”
  - Restatement of summary
  - Failing to provide specific, quantitative substantiation

Tables/Figures

Results

In this lab, the initial thickness and the hardness of a copper and brass sample were measured. The initial thickness measured was 0.25 in. The hardness of the samples of copper and brass were measured three times each before reducing the area of the sample in a rolling mill. The Rockwell Hardness B and F scale measurements are listed in tables one and two. From the values obtained during the lab, the average hardness, Vickers Hardness, and the percent reduction in area were calculated. The results obtained from this analysis are detailed in tables one and two for copper and brass, respectively.

Thickness (in)	Test 1 (HRF)	Test 2 (HRF)	Test 3 (HRF)	Average Hardness (HRF)	Vickers Hardness (HV)	%RA
0.248	49	50	51	50	56.85638	0.8
0.241	65	65	64	64.67	70.57526	3.6
0.223	76	77	77	76.67	84.60247	10.8
0.214	79	79	79	79	87.84022	14.4
0.196	82	82	82	82	92.3625	21.6
0.1825	84	84	84	84	95.64723	27
0.153	88	88	88	88	103.0375	38.8

Table 1

Tables/Figures

Table 1 – Results of grain size diameter measurement for the three alloys tested using ASTM E112

Sample	**Average Grain Size Diameter (μm) (Counting Method)**	**Average Grain Size Diameter (μm) (Buehler Omnimet)**
Iron (Fe)	69.5	44.9
Steel	44.9	15.9
Nickel (Friction Stir Welded)	22.5	7.9

Tables/Figures

- What is the story?
- Sufficient titling?

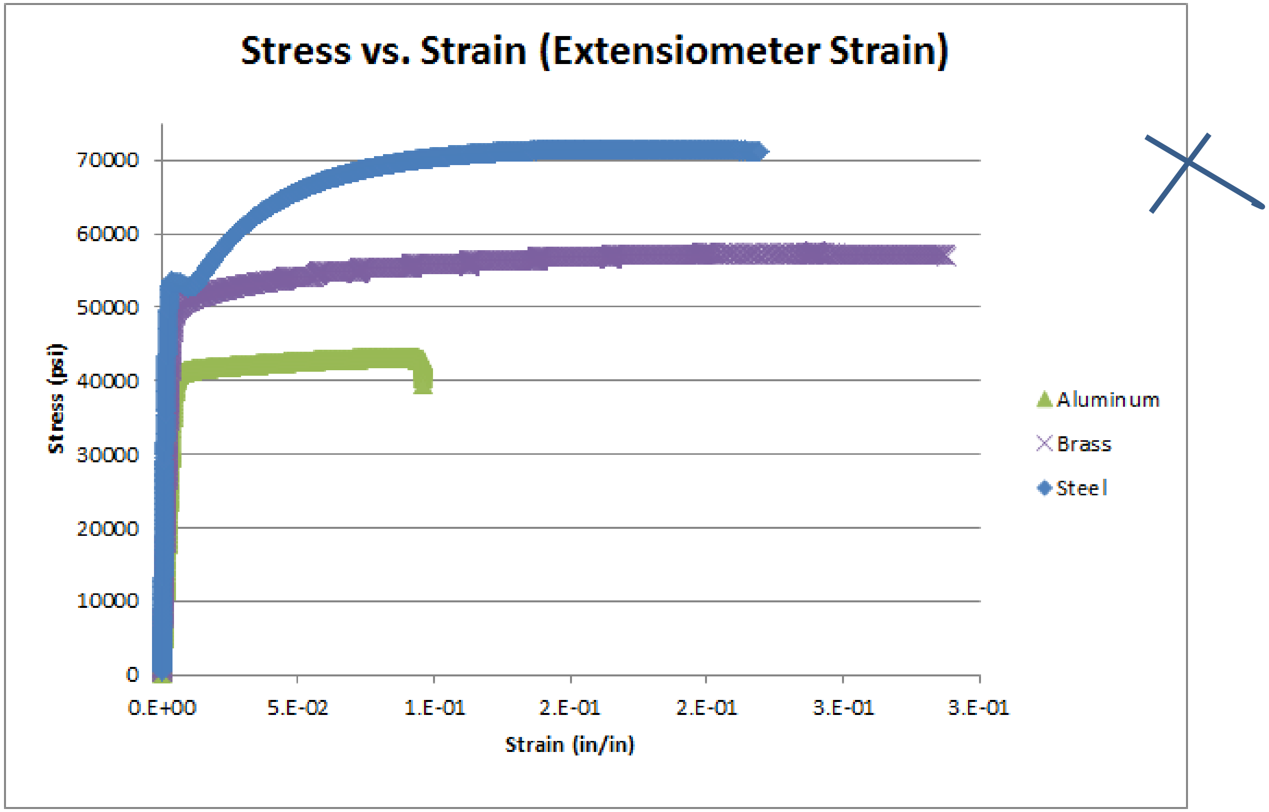


Figure 1. Curves

Tables/Figures

- Common issues
  - Uniform formatting
  - Significant figures
  - Improper titling/numbering
  - Insufficient Titling
  - Use of Microsoft defaults

Figure 1. Tester

- Rules
  - Titling: Table = Top, Figure = Foot
  - **<u>Direct referencing - All figures/tables must be directly referred to in the text before the figure appears</u>**
    - Table 1 shows the results of “x,y,z” vs. The results are summarized below (Table1).
  - Discussion - what does the figure show i.e. “what is the story”?

Tables/Figures

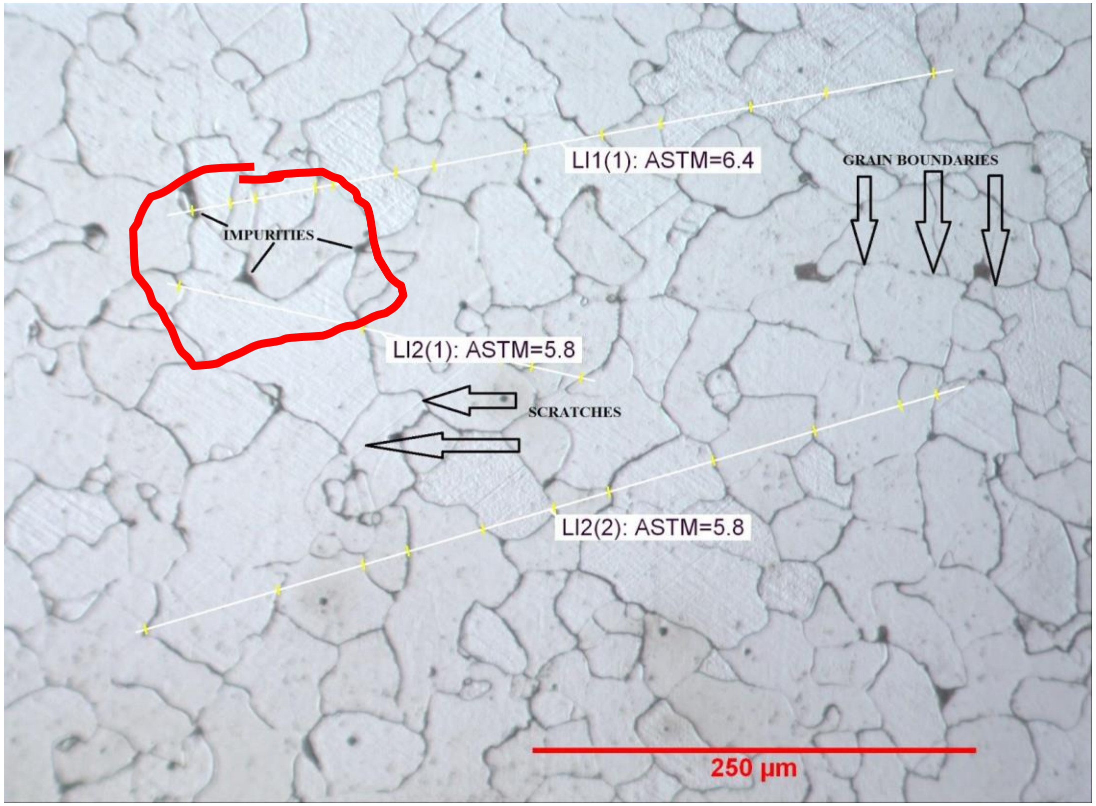


Figure 1 – Grain size measurement on iron sample (magnification = 300x)

Tables/Figures

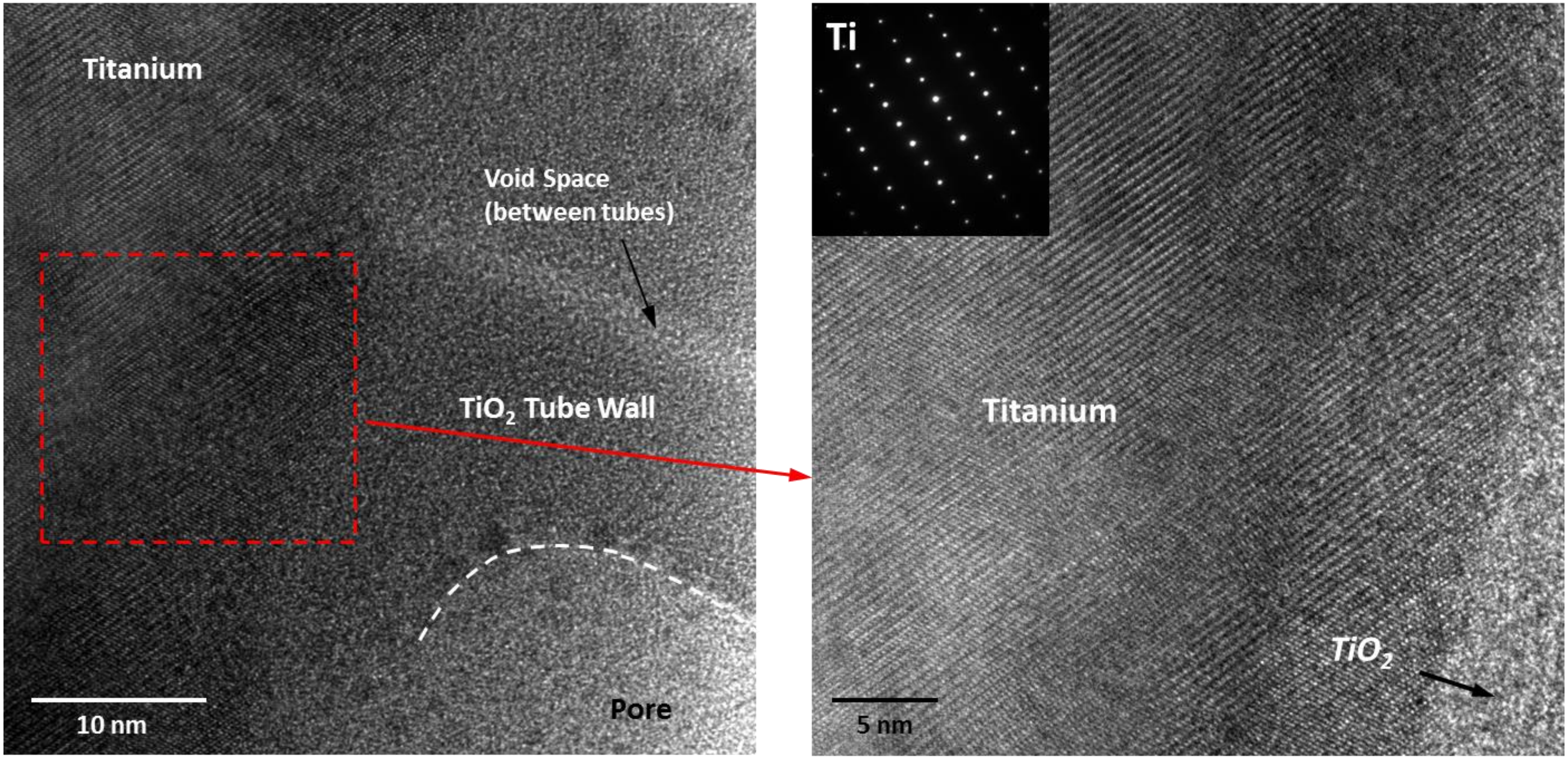


Figure 6 – Structure of titanium nanotubes showing interface between tube wall and pores.

Tables/Figures

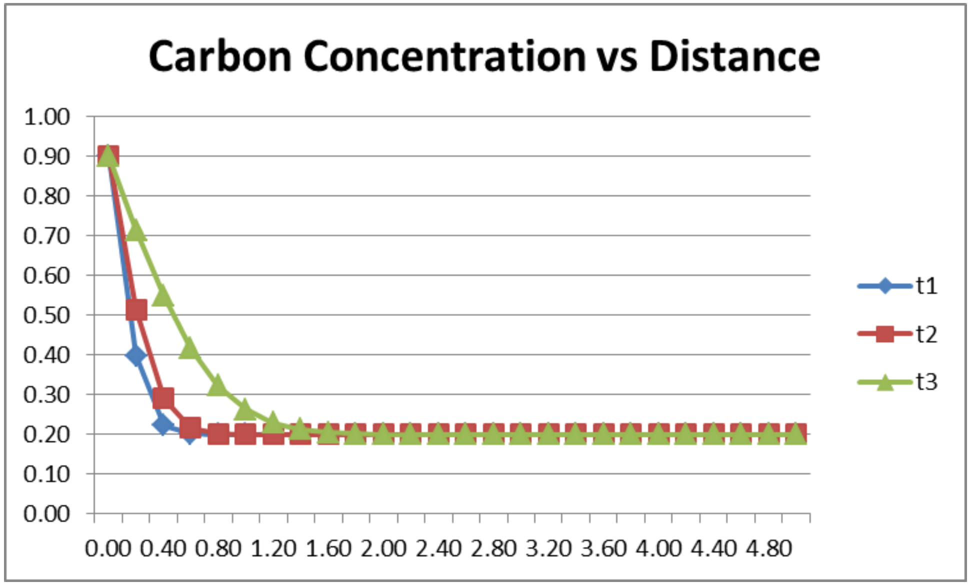
- Make use of auto-numbering figures and tables in word
  - Captions and cross-referencing
  - Table of contents

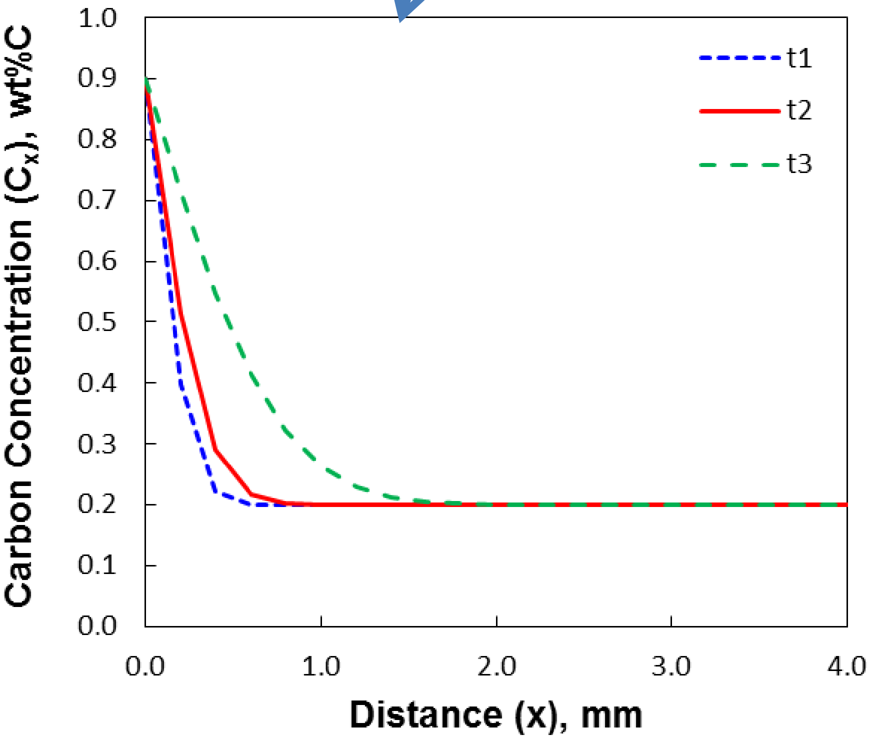
- Tutorial

http://www.youtube.com/watch?v=khHQUg2CVGw

Tables/Figures

- Avoid Microsoft Defaults   make graphs Professional





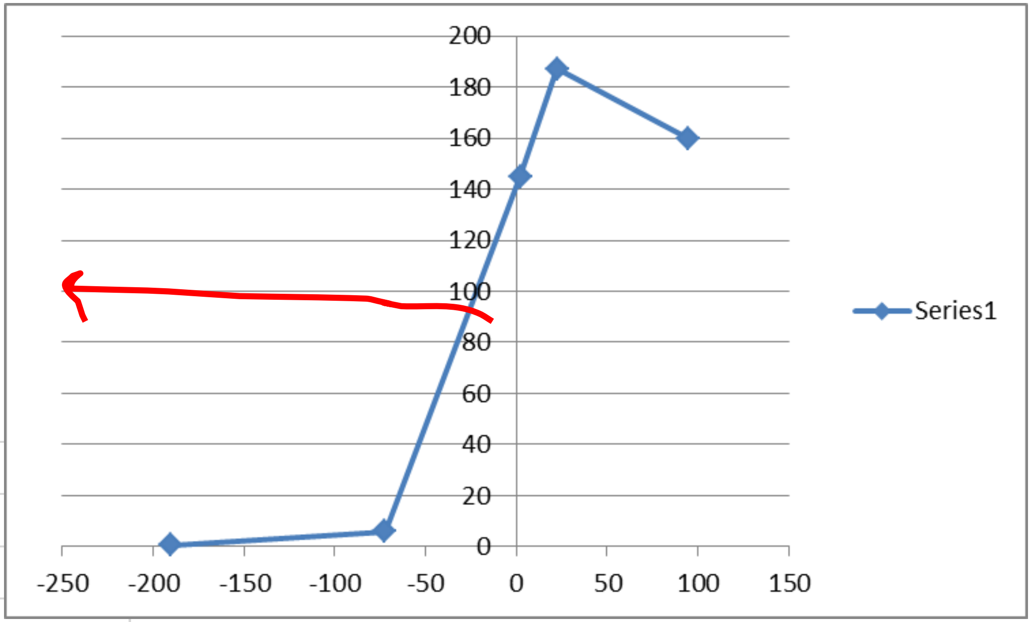
Tables/Figures

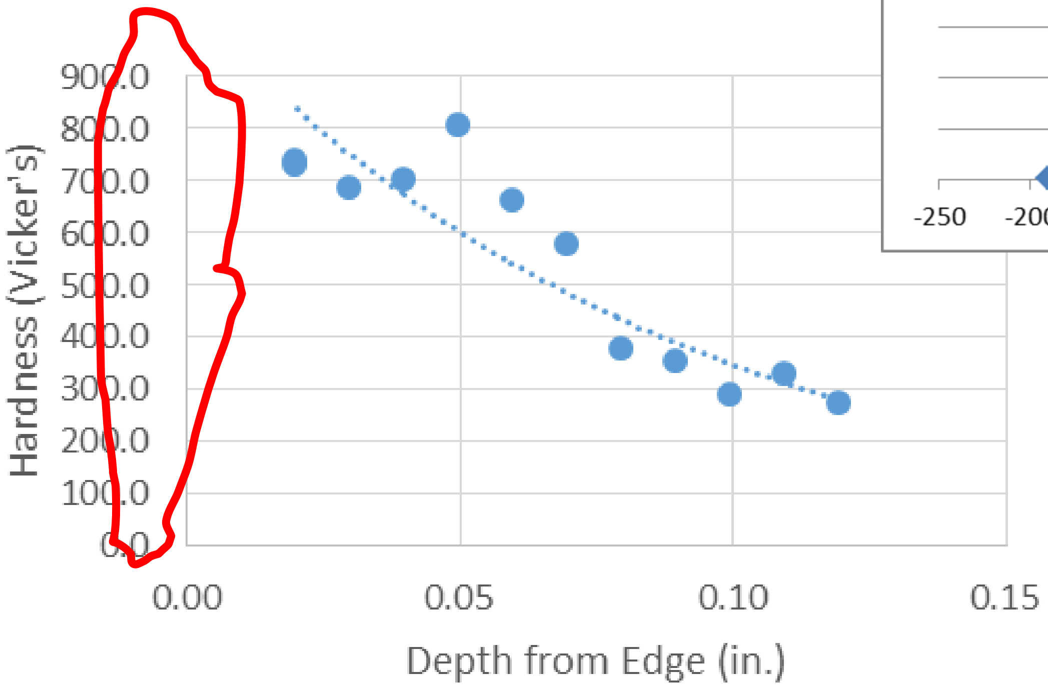
Tips

- Insert figures/tables “in-line” with text. No need to embed. Do not use text boxes for figure titles.
- OK to use an expanded, unbordered table cell for the title
- Reduce file size of large images (compress)
- Cutting and pasting (embedding vs. pictures)
- Reduce white space

Figures

- Significant Figures
- Connecting the dots, trendlines
- X-Y scatter plots





References

References

1. Callister Textbook 8th Edition
2. http://www.copper.org/applications/industrial/DesignGuide/props/cold_rolled.html
3. ASTM Standard B152
4. Dr. West Lecture notes
5. http://www.hardnesstesters.com/Applications/Rockwell-Hardness-Testing.aspx

References

- Common issues
  - Be consistent
  - Recommended formats:

Recently, a new chemical process was developed for eliminating nitrogen oxide emissions from diesel engines [2].

Recently, a new chemical process was developed for eliminating nitrogen oxide emissions from diesel engines [Perry and Siebers, 1986].

References

1. Owyoung, A. "High Resolution Coherent Raman Spectroscopy of Gases," in *Laser Spectroscopy IV*, ed. by H. Walther and K. W. Rothe (New York: Springer- Verlag, 1979), pp. 175-182.
2. Perry, R.A., and D. L. Siebers, "Rapid Reduction of Nitrogen Oxides in Exhaust Gas Streams," *Nature*, vol. 324, no. 2 (August 1986), pp. 657-659.
3. Steeper, R.R., "Reducing Nitrogen Oxides With Ammonia Injection," *Phys. Rev.*, vol. 13, no. 2 (1983), pp. 132-135.

***Use proper format for journals, books, online, interviews etc.**

Appendices

- Purpose - Detailed information that does not need to be included
  - Large amounts of raw data
  - Difficult intermediate calculations procedures, programs, spreadsheets, lengthy derivation details

Acknowledgments

- Important
  - Acknowledge partners and those who helped
  - Acknowledge specifically funding sources, grant numbers, etc.
  - NOT A SUBSTITUTE FOR AUTHORSHIP STATUS - Authors are those who were directly involved substantially in the work (other than processing, editing, and reviewing the writing).

Tech Writing Tips

- Writing and REWRITING!

- TRANSITIONS

- Use software tools to make things easier
  - Cross-referencing – use for tables and figures
  - References – make use of tools for managing references (Endnote)
- Do not tell the reader their feelings or mental state: avoid “Clearly”, “Obviously”, “Easily seen”, etc.

Grammar

- Use 3rd person
  - Avoid 1st person I/we (do not replace with student or user)
  - We created a decision matrix
  - Figure 1 shows the decision matrix used to select
- Proper tense
  - Be consistent
  - Use past tense for completed work/ Present for current analysis/ Future for future work
- Don't (Do not) use contractions.
- Use active rather than passive
  - *Based on the results of the initial experiments, later experiments for building FGMs were planned.*
  - *Vs.*
  - Phase II experiments were based on Phase I results.

Syntax and Word Usage

- Be concise (do not be wordy)
  - *The first group of FGM elements that were selected were nickel, chromium, molybdenum and tungsten (and/or tantalum). ThermoCalc®, DICTRA®, and binary phase diagrams were used for the selection process.*
- **Vs.**
  - ThermoCalc®, DICTRA®, and binary phase diagrams analysis suggested that nickel, chromium, molybdenum and either tungsten or tantalum as ---

Pet Peeves

- Studied
  - Real scientists and engineers never *study* they *investigate*, *measure*, and *determine*.
- Hopefully – Avoid altogether
  - **Hopefully, the judge will decide to levy the death penalty.**
- Due to – Avoid – Due to only means "caused by" Do not use it in the place of "because of"
  - *Nickel (Inconel® 625 and Inconel® 718) and cobalt (Stellite6 and Stellite21) based super alloys were chosen due to their high temperature applications and their wear and corrosion resistance.*
  - The high-temperature wear and corrosion resistance were deciding factors in selecting nickel-based Inconel® 625 and 718 and cobalt-based Stellite 6 and 21.
- Data – are (plural)
- Avoid the following types of wordy statements –
  - Due to the fact that…. -- In order to….
  - Strings of prepositions when adjectives would suffice