

The Impact of Materials on Society

Module 9 – Aluminum – Outline of Instruction for Faculty

This module examines how Aluminum was discovered and the evolution of its production from an extremely rare metal to a very common one. Aluminum first emerged as a metal in search of an application. This module examines the growth of the aluminum consumer market, and uses these lessons to anticipate the future of today's new amorphous metals. From a materials standpoint the module explores how alloying can influence the properties of a metal and how often in Material Science and Engineering one may discover a new materials and then try to find applications that best utilize the unique properties. From a social standpoint the module examines the birth of Alcoa, its subsequent breakup and the concept of monopolies and how one can deal with intellectual property. When an individual company or small set of companies has a dominant market hold on a new material, governments may step in to encourage competition and innovation. The flipped classroom explores potential applications for a new class of metals called amorphous metals. Understanding the business and legal dimensions of materials manufacturing is key to the application of intellectual property options to a new innovation.

Module Objectives

Students will:

- identify the properties of aluminum
- identify the properties of amorphous metals
- discover the uses and applications of aluminum both historically and in modern times
- examine the history and rationale of anti-trust legislation in the U.S.
- relate the ways that entrepreneurs and firms locate uses for new materials

Student Readings Assignment before Day 1

Read excerpt (pp. 186-197) from

Sass, Stephen L. (1998/2011) *The Substance of Civilization*. New York: Arcade Publishing.

Day 1 Class – Material Science & Engineering Lecture on Aluminum

Material Science Professor gives an overview of aluminum: explore the origin of early chemistry and how new elements were discovered including aluminum. The properties of aluminum are discussed as well as the history of aluminum production and the birth of ALCOA.

Materials Science Lessons

The concept of precipitation hardening is introduced and the Al Si phase diagram is discussed. Modern applications of aluminum are discussed along with recycling and sustainability.

Day 1 Lecture Development Resources:

1. **Lecture:** [Aluminum](#) PPT slides
2. **Sample Lecture Video:** [Aluminum](#) (19:56) ([Transcript](#))
Excerpts from Kevin Jones' lecture
3. **Demo Video:** [Aluminum experiment](#) (2:50)

Classroom Demo: The oxidation of Aluminum using concentrated HCL is shown to result in Al dissolution and the production of Hydrogen (which is lit).

Student Reading Assignment before Day 2

Read: [Aluminum Alcoa and Anti-Trust](#) by Prof. Sean Adams

Abstract: This chapter uses Alcoa to tell the story of aluminum and anti-trust. Although aluminum is quite common now, it was a very difficult metal to refine before 1888. One American company, Alcoa, was responsible for the rise in the application of aluminum to various markets. In order to increase production and profits, Alcoa grew in both size and scope, as did many American businesses during the early twentieth century. Eventually, this company controlled 2/3 of the world's supply. But as Alcoa emerged as a big business, federal policymakers considered it a dangerous threat to competitiveness in aluminum production. Using the doctrine of anti-trust, the United States successfully knocked Alcoa down from its lofty place in worldwide markets in 1945. In doing so, those policymakers believed they had struck a blow for competitiveness, but the larger question arises: is a company that dominates the production of a single material bad in and of itself?

Day 2 Class – Lecture on Alcoa, Anti-Trust and the Industrial Economy

Guest Professor presents “**Aluminum Alcoa and Anti-trust**” a lecture about the rise of Alcoa from a small business to the largest aluminum company in the world and its subsequent corporate evolution by anti-trust legislation. Alcoa played a large role in finding new applications for aluminum through its research laboratory in New Kensington, PA and dominated markets by the advent of World War II. The Justice Department determined that Alcoa’s market share was too large, and so used anti-trust legislation to break up the company. So, through innovation, efficiency, and experimentation Alcoa grew to a size considered unacceptable by the federal government. Is this 20th century case still relevant for new materials in the 21st century?

Social Lessons:

- 1) Creating new knowledge and innovations offers opportunities in the handling of intellectual property.

Day 2 Lecture Development Resources:

1. **Lecture:** [Aluminum , Alcoa and Anti-Trust](#) PPT slides by Sean Adams (UF)

Student Video and Homework Assignment before Day 3

Video: [Bulk Metallic Glass–Amorphous Metals](#) (15:15) ([Transcript](#))

You may also want to watch a second video (earlier version) entitled “[Amorphous Materials: Metallic Glass](#)” by Golden Kumar:

As you watch the video, consider answers to the following questions:

1. What are some of the enabling properties of metallic glass? What are some of the limitations of the properties of metallic glass?
2. What is involved in shaping or molding metallic glass?
3. What are some of the potential applications of metallic glass?
4. What are some of the challenges to developing applications of metallic glass?
5. After you watch this video, spend a little bit of time on the Internet investigating the business model and production needs of metallic glass. What competition exists in the marketplace for this new material?

Assignment:: [Module 9—Individual Homework Assignment](#) (Word)
Amorphous Metals Homework assignment due start of class Day 3

Please answer these questions in either bullet points or full sentences. Your responses will probably take ½ to 1 page. Assignment will be graded on effort, use of the lecture, video, and reading materials, and thoughtful reflection. Be sure your name is on the paper. A cover page is not necessary. See grading rubric below: We’ll build on your responses with the Day 3 in-class group activity.

Your grade on the essay will be based on the following criteria:

Grading Rubric.

2= Responses are appropriate, thoughtful, and indicate engagement with the video and any other required viewing/reading materials. Grammar, sentence structure and punctuation are correct.

1= Responses and arguments are incomplete and/or inconsistent with the required viewing/reading material. Some issues with grammar, punctuation and or sentence structure.

0= Responses are not appropriate to the assignment or missing entirely. Major issues with grammar, punctuation and or sentence structure.

Day 3 Class – Flipped Classroom Activity on Amorphous Metals and anti-trust

Key Concepts: Creating new knowledge and innovations offers opportunities in the handling of intellectual property.

Using the story of Alcoa and their experience with anti-trust, think about a firm that is involved in the production of amorphous metals and imagine that your research team has just made a breakthrough that allows for an inexpensive molding technique that will cut the cost of making cases for computers by a factor of ten. Although the technique could be patented, it also could be replicated and your firm has about a decade head-start on the competition in terms of actually supplying amorphous metal cases to market.

Part 1 - Do you patent the discovery which would protect you for 17 years until the patent runs out (of course you will have court costs from trying to enforce the patent) or do you try to keep it a trade secret (like the formula for coke) which could last forever but you also run the risk of someone else discovering how to do it and patenting the result before you? Explain your decision.

Part 2 – How would you approach the issue of anti-trust? Would you try to guarantee access to your technology from a number of firms, or instead fight any potential anti-trust prosecution as Alcoa did in its history?

Part 3 – Consider Robert Jackson’s argument on the need for anti-trust legislation in the industrial era. Do you think that the dynamics of the system he describes are still in place in the 21st century marketplace? Does technology make anti-trust policy unnecessary or essential? Explain

Your grade will be based on the following criteria:

Grading Rubric.

5= Responses are appropriate, comprehensive, and indicate thoughtful engagement with the information and concepts from the lecture, readings, and videos. Novel ideas, creativity, and attention to complexity are a plus

4= Good effort. Responses and arguments are not as clearly presented, or as comprehensive and thoughtful as in a full credit answer.

3= Responses are less appropriate to the assignment, less thoughtful and engaged, with less complete information. Errors in grammar, punctuation and or sentence structure will also result in loss of points

2= Responses are incomplete, showing little effort, thought, or use of preparatory materials.

1= Responses are not consistent with preparatory materials. Assignment is badly incomplete. Next to no effort.

Day 3 Lecture Development Resources:

1. **In-Class Activity:** [Module 9—Individual Homework Assignment](#) (Word)

Complete Impact Paradigm Assignment:

Thinking about the material that we covered in this week's unit, add another question to the impact paradigm.

- **Assignment:** [Module 9—Impact Paradigm Individual Homework Assignment](#) (Word)

Additional Resources:

Online Course Module

- View the online Module 9 in [Word](#) or [PDF](#) format
- Available soon: The full online course to upload to your Learning Management System. Contact Kevin Jones at kjones@eng.ufl.edu or Pamela Hupp at hupp@mrs.org for more information.

Articles:

- a. Jackson, Robert H. "Should the Antitrust Laws Be Revised?" *United States Law Review* 17 (1937): 575-582.

Videos:

- a. Golden Kumar. [Amorphous Metals: Metallic Glass](#) (31:00) video