**The Impact of Materials on Society**

**Module 5 - Gold and Silver – Outline of Instruction for Faculty**

Humans give value to materials in many different socially-informed ways. This module examines the creation of currency systems based on gold and silver, and uses these lessons to explore how we perceive the use of gold nanoparticles in medicine today. Finding new uses for materials may depend upon the value that we give to them in other circumstances. How might we give new forms of value to precious metals that change how we think about their utility and value in our society? (And how have new processing techniques altered how we understand the most valuable properties of these materials?)

**Module objectives**

Students will

* identify the properties of gold and silver
* discover the uses and applications of gold and silver both historically and in modern times
* identify the properties of nanomaterials
* discover the uses and applications of nanomaterials in modern times and projecting into the future
* analyze the intrinsic and perceived value of materials
* distinguish exchange from trade and identify the main elements of the theory of exchange

**Student Reading Assignment before Day 1**

Read excerpt (pp. 68-81) from

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

**Day 1** **Class – Material Science & Engineering Lecture on Gold and Silver**

Material Science Professor gives an overview of gold and silver: properties, abundance, structure and location; manipulation, malleability, and the history of gold and silver; native vs. smelted, impurities, Roman amalgamation, liquation; Irish gold and the Gold Rush of 1848.

**Materials Science Lessons**

Gold’s (and to a lesser extent silver’s) abundance and relatively inert chemical properties led it to be the material of choice for storage of wealth, and its unique properties are now affording other applications e.g. microelectronics and nanomedicine

**Day 1 Lecture Development Resources**:

1. **Lecture:** [Gold & Silver](http://www.mrs.org/docs/default-source/programs-and-outreach/imos-course/module-5/gold-and-silver-ppt.ppt?sfvrsn=0) PPT slides
2. **Sample Lecture Video:** [Gold and Silver](https://www.youtube.com/watch?v=C17AfTmL4TI&feature=youtu.be) (22:18) ([Transcript](https://cluster30-files.instructure.com/courses/1016~323949/files/1016~27251691/course%20files/lecture%20video%20transcripts/IMOS_Gold_Transcript.txt?download=1&inline=1&sf_verifier=&ts=&user_id=))
Excerpts from Kevin Jones' lecture

**Classroom Demo**: show gold nanoparticles in solution and perhaps manipulate a gold bead into a sheet through hammering

**Student Reading Assignment before Day 2**

**Read**: [*Gold and Silver: Precious Metals and Coinage*](http://www.mrs.org/docs/default-source/programs-and-outreach/imos-course/module-5/module-5---gold-by-florin-curta-2015-wtmk.pdf?sfvrsn=4)by Florin Curta

*Abstract: Until the late 20th century, there were very few “technological” applications of precious metals. Despite the occasional use of silver in medicine and of gold in dentistry manufacturing of jewels, sacred vessels (such as used in the liturgy in the Church), and, especially, coins. Complex societies, such as ancient Egypt or Mesopotamia, used both gold and silver as money (standard of value and means of exchange) but not as coins. Coins were invented in three different places at three different times, but in all cases coined money fulfilled a number of key functions, and the selection of silver and gold to strike coins was directly associated to those functions. The earliest coins were in fact struck not in gold and not in silver, but in a naturally occurring alloy of both, known as electrum. When in the 6th century city-states in Greece began to strike coins in large numbers, the metal they chose was silver, with gold coming into use on a large scale only since the 4th century B.C. Coined money is based on the idea that the quantity and quality of the metal in the coin is guaranteed by some authority, often that of the state. The coin thus circulates at a value higher than that of the metal of which it is made. Coined money introduced the conceptual distinction between intrinsic and extrinsic value.*

**Day 2 Class** **– Lecture on** **Precious Metals and Coinage**

Guest Humanities/Archaeology Professor presents **Gold, Silver, and the Creation of Value**. Coinage and trade, intrinsic vs. perceived value of materials, physical properties, and theory of exchange.

**Watch Video:** [Roman coins](https://www.youtube.com/watch?v=GEFksaqdrjg) (34:22) video at start of lecture

**Social Lessons:**

1. **Intrinsic vs. perceived value of materials.** In the process of exchanging goods, humans have the tendency to attribute “additional” value to materials, based on perceived (as opposed to real) properties. The theory of value thus differentiates between the intrinsic properties typically valued for technological applications, and the perceived value of the material which may have little, if anything to do with its intrinsic properties.

**Day 2 Lecture Development Resources:**

1. **Lecture:** [Precious Metals and Coinage](http://www.mrs.org/docs/default-source/programs-and-outreach/imos-course/module-5/module-5---day-2-lecture---precious-metals-and-coinage-wwmrk.pptx?sfvrsn=4) (PPT) slides by Prof. Florin Curta (UF)

**Classroom Demo:** bring ancient coins (from the local museum or a private collection) to class.

**Student Video and Homework Assignments before Day 3**

**Watch Video:** [Gold](https://www.youtube.com/watch?v=Kbf4Nqy7WdE) (8:25) ([Transcript](https://cluster30-files.instructure.com/courses/1016~323949/files/1016~27246884/course%20files/BWE%20video%20transcripts./08%20Gold%20Transcript.txt?download=1&inline=1&sf_verifier=&ts=&user_id=))

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

1. Why are nanomaterials being considered for drug delivery?
2. What properties of nanomaterials are important to improve their efficacy?
3. How may the use of nanomaterials benefit cancer therapies?
4. What concerns should we bear in mind when developing these materials?
5. There are seven basic properties of gold (relative density, ductility, malleability, melting point, optical properties, alloying properties, and oxidation potential). Are the properties of gold that *afford* nanomaterials for drug therapy different than the properties of gold that afford other applications of this material?
6. Look back at your reading assignments from this week and surf around the Internet a little to remind yourself of some of the many technologies and material products created using gold. Think about how these products reflect gold’s intrinsic value. How does the use of gold in nanomaterials for cancer therapy add extrinsic value to gold’s existing intrinsic value?

**Assignment:**  [Module 5—Individual Homework Assignment](http://www.mrs.org/docs/default-source/programs-and-outreach/imos-course/module-5/module-5---individual-homework-assignment-updated.docx?sfvrsn=4) (Word)

Nanomaterials 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 Gold and Silver**

**Key Concepts:** Value is a social concept that is assigned to a material based on many factors. Materials have intrinsic physical properties, only some of which are selected as more relevant by a society in meeting social needs based on cultural perspectives. But, a material’s use can change and this can affect its financial value.

**Day 3: Classroom Activity: Perceived (extrinsic) value vs intrinsic value of gold.**

**Pre-Class Assignments:** Gold video, nanomaterials homework assignment

**Societal Concept:** Materials have intrinsic physical properties, only some of which are selected as more relevant in shaping society based on cultural perspectives. A material’s use can change.

*Please make sure to answer these questions in order, beginning with #1.*

1. We consider gold to be valuable because it is has a unique set of physical properties. List in order what you consider to be the top 6 properties that most influence its value in your opinion.
2. What is the current value of an ounce of gold? How would you think the advent of an engineering application (e.g. gold particles for nanomedicine) of gold might affect its financial value? Explain your opinion.
3. If a typical dose of gold nanoparticles is 2 milligrams/kilogram of body weight and the average person weigh 150 lbs. How much gold is in a typical dose of cancer treatment? If the shot costs $800, what percent of the cost is associated with the cost of the gold?
4. Give a rough estimate of the percentage of the world’s production of gold that could go into nanomedicine if it’s completely adopted in the US to treat pancreatic cancer. (You will need to figure out how many people have the cancer you are treating and assume some arbitrary number of treatments per year, say 10, as well as locate information on the average yearly production of gold.) Now that you’ve done the math, do you think this will measurably impact the financial value (or cost) of gold? Explain.
5. So you are the president of a company and your scientists have come up with two possible solutions for a cancer treatment. One uses Tantalum nanoparticles and one uses Gold nanoparticles and they both had the same effectiveness which one would you choose and why?
6. What considerations related to the operational chain involved in gold e.g. gold’s mining, pollution, trade, recyclability etc. might impact its perceived value
* Refer to[Day 3 In-Class Activity: Gold and Silver](http://www.mrs.org/docs/default-source/programs-and-outreach/imos-course/module-5/module-5---day-3-in-class-activity---gold-and-silver.docx?sfvrsn=4)worksheet for specific instructions.
* Refer to the rubric for grading criteria.

**Your grade will be determined from the following criteria.**

Grading Rubric.

5= Responses are appropriate and indicate engagement with the preparatory material.  Grammar, sentence structure and punctuation are correct.

4= Responses and arguments are not as clearly presented. Some minor issues with grammar, punctuation and or sentence structure.

3= Responses are not appropriate to the assignment and do not reinforce the physical and cultural properties of materials.  Mistakes in grammar, punctuation and or sentence structure.

2= Responses are incomplete.  Major problems with grammar, punctuation and or sentence structure.

1= Responses are inconsistent with material covered in class, videos, and readings. Missing elements of assignment.  Poor grammar, punctuation and or sentence structure.

**Day 3 Lecture Development Resources:**

1. **Assignment:** [Module 5—Day-3 In-Class Activity Assignment](http://www.mrs.org/docs/default-source/programs-and-outreach/imos-course/module-5/module-5---day-3-in-class-activity---gold-and-silver.docx?sfvrsn=4) (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 5—Impact Paradigm Individual Homework Assignment](http://www.mrs.org/docs/default-source/programs-and-outreach/imos-course/module-5/module-5---day-3---impact-paradigm-assignment.docx?sfvrsn=4) (Word)

**Additional Resources:**

**Online Course Module**

* View the online Module 5 in [Word](http://www.mrs.org/docs/default-source/programs-and-outreach/imos-course/module-5/5_module_outline_gold_and_silver.docx?sfvrsn=4) or [PDF](http://www.mrs.org/docs/default-source/programs-and-outreach/imos-course/module-5/5_module_outline_gold_and_silver8f21b38cc9d76e4e916fff0000759bd3.pdf?sfvrsn=4) 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.

**Videos:**

1. Alain Bressen: [The Greek Way of Handling Money](https://www.youtube.com/watch?v=N0muWKVW1yg) (46:59)
2. Chad Mirkin: [Gold Nanoparticles & The Future of Medical Diagnostics](https://www.youtube.com/watch?v=_MgMiK7LKc8) (6:18)
3. Naomi Halas: [Just Imagine](https://www.youtube.com/watch?v=HU0yLC02zIA&feature=related) (0:50)
4. National Science Foundation and NBC Learn. "[Nanotechnology: Super Small Science: Nanosensors](http://www.nsf.gov/news/special_reports/nanotechnology/06_nanosensors.jsp)." Video. National Science Foundation.
5. Piotr Grodzinski: [Medicine: Diagnosis & Treatment; Nanoparticles for Cancer](https://www.youtube.com/watch?v=GvARaEXDcG4) (30:12) video