Materials Science: The Missing Piece

A Study on Incorporating Materials Science Curriculum into Standard High School Science Curriculum and Creating a Materials Science Course

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March 8, 2010

Overview

- Introduction to Materials Science
- History of Materials Science Curriculum
- Study Done at the Manoogian School
- Results of Study

What is Materials Science?

- Focus on the chemistry, physics and engineering of solids
- Metals, ceramics, polymers, and composites
- Often part of engineering curriculum at the university level

Why is Materials Science Important?

"Everything is made out of something and it always will be."

"People who spend their time thinking about how to make stuff, and how to make stuff better, will likely never run out of stuff to do."

Austin , Jim. Careers in Materials Science: Feature Index. 5 November, 2004. *Science Careers*.

Why Should Materials Science Be Included in Standard Curriculum?

- Connection to chemistry and physics
- Chemistry of solids often neglected
- Practical applications
- Real-world connections
- Increase interest in science
- Introduction to Materials Science and Engineering
- Critical technology

Why Should Materials Science Be Included in Standard Curriculum?

- Career and Technical Education
- School to Work
- National Standards
- America COMPETES

History of Materials Science as High School Curriculum

- 1960's and 1970's – short units created and shared with teachers across the U.S.
- 1970's – Resources in Technology (VA)
- 1976 – Pacific Northwest National Laboratory (Richland, WA)
  - Materials Science and Technology Teacher's Handbook (1992)

History of Materials Science as High School Curriculum

- 1980's – Center for Implementing Technology Education, Ball State University
- 1996 – Materials World Modules, R.P.H. Chang, Northwestern University
- 1996 – Materials Science and Technology (MAST) Modules, University of Illinois
- 1997 – 2008 – Energy Concepts, Incorporated

History of Materials Science as High School Curriculum

- 1996 – 2003 - Materials Science and Technology Institute at University of Washington
- 2002-2008 - ASM Materials Education Foundation
  - Materials Camp for Teachers
    - 25 camps in 2009
    - 1 week long program free to teachers
  - Materials Camp for Students

Success in High Schools

- Washington, California, Oregon, Florida, New Mexico, Missouri, New England states
- Offered as career and technical education or for science credit
- Increased number of entering university students interested in materials science and engineering

Materials Science at the A.G.B.U. Alex & Marie Manoogian School

- 2 phases of study
  - 2006-2007 – Addition of activities to standard science curriculum
  - 2007 – 2008 – Development and implementation of a one semester elective course for 10^{th} – 12^{th} grade students
  - 2009 – 2010 – Continuation of elective course

Units Covered

- Solids
- Metals
- Polymers
- Ceramics
- Composites

Solids

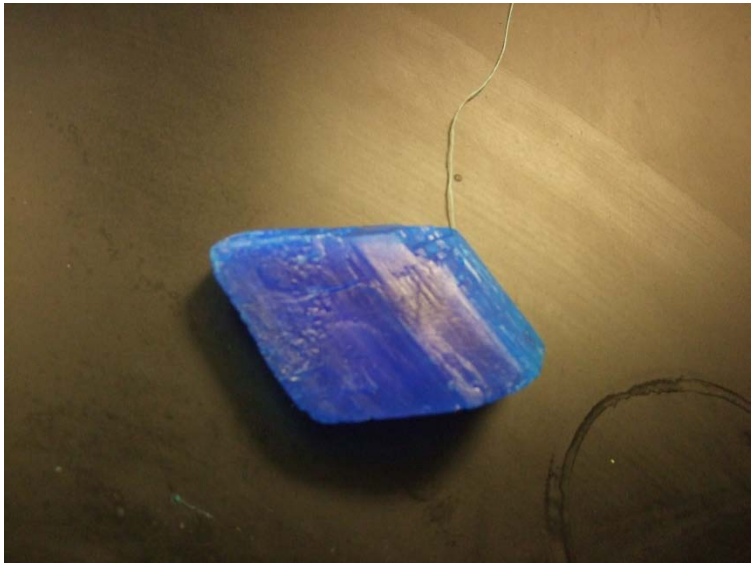
- Basic classification of solids
- Chemical, physical, and mechanical properties
- Chemical structure – amorphous or crystalline
- Crystal structure and growth
- Changing properties – work hardening and heat treating

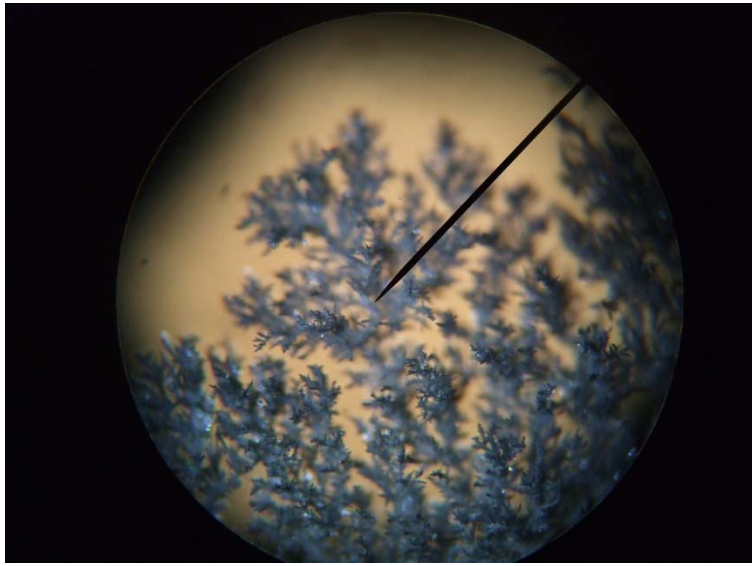
Solids

- Cornstarch and water – properties of solids and uses for solids

Solids

- Growing crystals





Metals

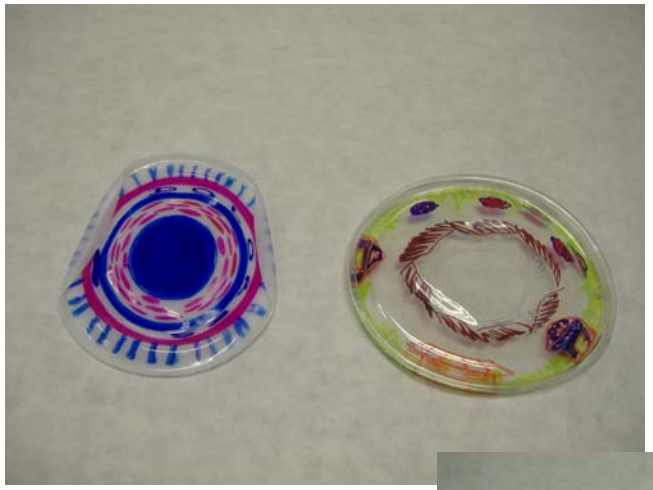
- Physical and chemical properties
- Reactivity with activity series
- Oxidation and reduction
- Malleability and ductility
- Alloys
- Casting
- Memory metal
- Lost wax casting

Metals

Polymers

- Chemical structure and properties
- Formation
- Natural versus synthetic
- Cross-linking
- Classification – thermoset, thermoplastic, elastomer
- Changing properties with heat
- Practical applications

Polymers



Ceramics

- Properties
- Comparison with metals and polymers
- Heating, bending, stretching, and blowing glass
- Ceramics as metal oxides
- Making glass

Ceramics

Composites

Did not get to cover due to lack of time

- *Snack bar*
- *Polystyrene and duct tape*
- *Ice hockey pucks*
- *Cement*

Student Survey Data

- General Classes
  - 56 students surveyed
  - 46% male, 54% female
    - 23 in 9th grade – 9 activities
    - 9 in 10th grade – 6 activities
    - 9 in 11th grade – 3 activities
    - 15 in 12th grade – 6 activities

General Survey Questions

- I am a
  - Freshman
  - Sophomore
  - Junior
  - Senior

- I am
  - Male
  - Female

- Check which of the following activities or experiments you remember doing :

  - Materials ID – classification of materials
  - Classifying matter with nuts and bolts
  - Packing peanuts in different liquids
  - Happy/Sad Balls
  - Making slime
  - Making a bouncy ball from white glue
  - Making a polymer foam
  - Polarizing film
  - Shrinking a plastic cup

General Survey Questions

- Doing these experiments increased my interest in science class.
  - Agree
  - Disagree
  - Not sure

- Doing these experiments increased my understanding of science concepts.
  - Agree
  - Disagree
  - Not sure

General Student Survey Data

- Calculated the percentage of people who remembered each activity
- On average, 80% of students retained knowledge of a particular activity
- 96% reported increased interest in science class, 4% not sure
- 92% reported increased understanding of science concepts, 8% not sure

Materials Science Student Survey Data

- What are materials?
  - 9 of 13 refer to everyday objects, 2 science, 1 specific
  - Increase to 3 science and 3 specific
- What is Materials Science?
  - 5 increase understanding
- Why do people study Materials Science?
  - 5 increase understanding, 1 specific to engineering

Materials Science Student Survey Data

- I am interested in science and planning to pursue a career in science.
  - 54% yes 46% no
- I was not considering a career in science before this course, but now I am.
  - 38% yes 62% no

Materials Science Student Survey Data

- I was not considering a career in Materials Science or a related field before this course, but now I am.
  - 46% yes 54% no
- This course has helped me to develop skills in using tools and equipment I did not know how to use before.
  - 92% yes 8% no

Materials Science Student Survey Data

- Taking the Materials Science class has increased my interest in science.
  - 38% Definitely agree 54% Somewhat agree
  - 8% Already had a high interest 0% No
- Taking the Materials Science class has increased my understanding and knowledge in science.
  - 54% Definitely agree 46% Somewhat agree

Materials Science Student Survey Data

- Materials Science has given me new skills that will probably be helpful in a future class, job, or college.
  - 54% Yes 46% Unsure 0% No
- I would recommend this class to others.
  - 92% Yes 8% Unsure 0% No

How has your understanding of Materials Science changed?

"It has totally changed. I never even knew it existed."

"I didn't know too much about it. Now I know A LOT!!!"

"I have a better understanding of how things around me work."

How has this class helped you in other places?

- ACT and MME – 4 students
- Chemistry class – 5 students
- English and other science class – 2 students
- Everyday understanding – 5 students

What did you like or dislike?

- 29 positive comments
  - “Fun”, “Cool”, “Interesting”
  - Hands-on learning
  - Did new things
- 15 negative
  - Written work – 9 comments, similar to previous study
  - Nothing – 2 comments

Student Comments

"I thoroughly enjoyed this semester of Materials Science. I've learned so much and did so much. It is one of the best electives I have taken and I am the school offered it."

"Amazing class! I love lab activities and all the random things we made. I was so happy how this class helped me in my Chemistry class. I definitely did better in Chemistry after taking Materials Science."

Student Comments

"This class is the only reason I enjoy coming to school."

"This is the only thing I actually find interesting in school."

"Can't all classes be like this?"

Conclusion

- Adding Materials Science to middle or high school curriculum is very beneficial
- Teaching a Materials Science class is also extremely rewarding
- Teachers should be encouraged to learn more about Materials Science so they can pass it on to students

Contact Information and Acknowledgements

- http://asmcommmunity.asminternational.org/portal/site/www/Foundation/Educators/TeachersCamp/

- ASM International – Materials Education Foundation

- Lisa Ogiemwonyi

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