SCSU CRISP CCSA Kit Pages 2016

Title of Module: Amorphous Metals: Atomic Trampoline

Subject or Unit of Study: Properties of materials, Amorphous metals, Mechanics

GRADE LEVEL____5-12+_____ **LENGTH OF DEMO/LESSON**: _____

STUDENT OBJECTIVES
Students will...

- Demonstrate properties of amorphous metals
- Explain how chemical structure can cause interaction with difference materials

NEXT GENERATION SCIENCE STANDARDS

NGSS Performance Tasks	**MS-PS1-1 Matter and its Interactions** • Develop models to describe the atomic composition of simple molecules and extended structures. **HS-PS1-3 Matter and its Interactions** • Plan and conduct an investigation to gather evidence to compare the structure of substances at the bulk scale to infer the strength of electrical forces between particles.
NGSS Disciplinary Core Ideas (DSI)	**MS - PS1.A: Structure and Properties of Matter** • Substances are made from different types of atoms, which combine with one another in various ways. Atoms form molecules that range in size from two to thousands of atoms. • Solids may be formed from molecules, or they may be extended structures with repeating subunits (e.g., crystals). **HS-PS1.A: Structure and Properties of Matter** • The structure and interactions of matter at the bulk scale are determined by electrical forces within and between atoms.
NGSS Cross Cutting Concepts (CCC)	**MS CC 3 - Scale, Proportion, and Quantity** • Time, space, and energy phenomena can be observed at various scales using models to study systems that are too large or too small. **HS CC1 - Patterns** • Different patterns may be observed at each of the scales at which a system is studied and can provide evidence for causality in explanations of phenomena.
NGSS Science and Engineering Practices (SEP)	**MS SEP 2 – Developing and Using Models** • Develop a model to predict and/or describe phenomena. **HS SEP 3 – Planning and Carrying out an investigation** • Plan and conduct an investigation individually and collaboratively to produce data to serve as the basis for evidence, and in the design: decide on types, how much, and accuracy of data needed to produce reliable measurements and consider limitations on the precision of the data (e.g., number of trials, cost, risk, time), and refine the design accordingly.

COMMON CORE STANDARDS

CC-ELA/Literacy Standards	**RST.11-12.1** • Cite specific textual evidence to support analysis of science and technical texts, attending to important distinctions the author makes and to any gaps or inconsistencies in the account. (HS-PS1-3) **WHST.9-12.7** • Conduct short as well as more sustained research projects to answer a question (including a self-generated question) or solve a problem; narrow or broaden the inquiry when appropriate; synthesize multiple sources on the subject, demonstrating understanding of the subject under investigation. (HS-PS1-3) **WHST.11-12.8** • Gather relevant information from multiple authoritative print and digital sources, using advanced searches effectively; assess the strengths and limitations of each source in terms of the specific task, purpose, and audience; integrate information into the text selectively to maintain the flow of ideas, avoiding plagiarism and overreliance on any one source and following a standard format for citation. (HS-PS1-3) **WHST.9-12.9** • Draw evidence from informational texts to support analysis, reflection, and research. (HS-PS1-3) **RST.6-8.7** • Integrate quantitative or technical information expressed in words in a text with a version of that information expressed visually (e.g., in a flowchart, diagram, model, graph, or table). (MS-PS1-1)
CC-Math	**HSN-Q.A.1** • Use units as a way to understand problems and to guide the solution of multi-step problems; choose and interpret units consistently in formulas; choose and interpret the scale and the origin in graphs and data displays. (HS-PS1-3) **HSN-Q.A.3** • Choose a level of accuracy appropriate to limitations on measurement when reporting quantities. (HS-PS1-3) **MP.2** • Reason abstractly and quantitatively. (MS-PS1-1) **MP.4** • Model with mathematics. (MS-PS1-1) **6.RP.A.3** • Use ratio and rate reasoning to solve real-world and mathematical problems. (MS-PS1-1) **8.EE.A.3** • Use numbers expressed in the form of a single digit times an integer power of 10 to estimate very large or very small quantities, and to express how many times as much one is than the other. (MS-PS1-1)

MATERIALS
List all materials needed for this lesson/demonstration

- 1 stainless steel base
- 1 stainless steel base with a 1/8 inch thick disk of Liquidmetal® (Zr41.2Be22.5Ti13.8Cu12.5Ni10.0) glued to it
- 2 clear plastic tubes which slide over the top of the bases
- 2 hardened steel ball bearings
- Booklet complete with pictures and figures which help explain the behavior of the amorphous metal, as well as some other activities to try with the demonstration set-up

SAFETY

- Liquidmetal® contains zirconium, copper, titanium, nickel and beryllium. Several of these elements are highly toxic. Although the disks are perfectly safe and can be handled without special precautions, do not polish, sand, scratch, file, or chip the Liquidmetal® disk. This will ensure that particles of the alloy do not come in contact with skin and cannot be ingested.

LEARNER BACKGROUND
Describe the students' prior knowledge or skill related to the learning objective(s) and the content of this lesson, using data from pre-assessment as appropriate.

Students should understand what a metal alloy is. They should know what an amorphous materials

LEARNING ACTIVITY OR PROCEDURE:
Explicitly layout the lesson or demonstration

See Atomic Trampoline guide provided by the Institute for Chemical Education at the University of Wisconsin-Madison NSF MRSEC

TEACHER NOTES:

- This demonstration can be used as a discovery experiment for a small or large group of students. For example, provide students with some skeletal information about the two materials and their structures, and ask the students to propose possible explanations for the different physical properties. Encourage them to "test" the rebound characteristics of other materials around the classroom (i.e., wood, plastic, cement, or other metals) by placing the plastic tube over the material and watching the ball bounce. Based on their knowledge of the structures of these other materials, they may amend or extend their proposed explanation.
- Ask students to measure the coefficient of restitution for the Liquidmetal~ alloy and the aluminum, as well as other materials in the classroom using the aluminum (or other) balls. If a video camera is available, students can videotape the demonstration with a meter stick held in place next to the plastic tube. This will allow them to review the tape and make more careful height measurements

STEM CAREERS:
Material scientist
Biochemical engineer
Chemist
Researcher
Engineer
Industrial Engineer
Materials Engineer
Nanotechnologist