Alloys

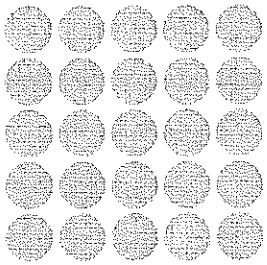
How are alloys made and what properties do they have?

Why?

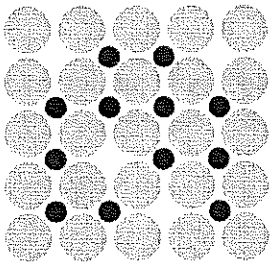
Metals are amazing, and they are all around us. You can probably easily identify them by their shiny surfaces and tinny sound when you tap them. We use metals to run electricity through our house, manufacture our cars, and create circuits for our phones. However, most metals in their pure form are less than perfect for these jobs. Luckily, the properties of metals can be manipulated to make them more useful by adding other elements to form a mixture. These mixtures are called **alloys**. In this activity, you will look at two types of alloys and their properties.

Model 1 – Two Types of Alloys

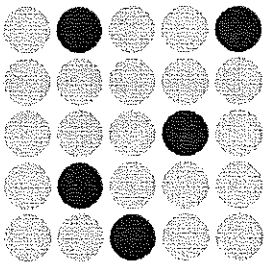
Pure Metal



Interstitial Alloy



Substitutional Alloy



1. Name the two types of alloys illustrated in Model 1.

2. According to Model 1, how is an alloy different from a pure metal?

3. Consider the two types of alloys in Model 1. Based on the diagrams and your understanding of English words, define "substitutional" and "interstitial."

4. One of the alloys in Model 1 tends to form when elements with similar sized atoms are melted together and allowed to cool. The other type forms when elements with very different sized atoms are combined. Match the descriptions below with each type of alloy.

   Component atoms are similar size.

   Component atoms are different sizes.

Read This!

It is possible to mix two metal elements together and simply form a mixture of metals that would not be considered an alloy. The distinction is in the properties that result from the mixture. If the addition of an "impurity" to the metal somehow causes a change in a property that is beneficial, then the mixture is considered an alloy. If however the "impurity" results in weakening the metal or causes less desirable properties, then it is considered simply a mixture.

5. Solids are most stable when the arrangement of atoms in the crystal lattice minimizes bond length, maximizes bond strength, and maximizes the number of atoms "touching" one another—in other words, when the atoms fill the space most efficiently.

   a. Explain why an interstitial alloy would not form a stable crystal structure if the component atoms were of similar size. Sketch a diagram to illustrate your answer.

   b. Explain why a substitutional alloy would not form a stable crystal structure if the component atoms were different sizes. Sketch a diagram to illustrate your answer.

6. Consider how the density of an alloy might compare to the density of the original metals.

   a. Would substitutional alloys tend to have a density similar to, significantly greater than or significantly less than the pure metal? Explain your reasoning.

   b. Interstitial alloys oftentimes have a density less than the pure metal. Explain how the addition of a small, low mass atom like carbon could make the density of an interstitial alloy less than the pure metal.

7. Metals are malleable because of weak bonds between atoms. This allows planes of atoms to slide past one another and into new positions. Some alloys retain their malleability while others become more rigid. Consider the diagrams in Model 1. Predict which type of alloy would result in a more rigid substance. Justify your reasoning.

Extension Questions

8. Listed below are the components of several common alloys used in industry today. Use a reference table of atomic radii to determine if the alloy is likely to be interstitial or substitutional based on what you learned from Model 1.

Alloy	Components	Atomic Radii	Type of Alloy Structure
Brass	Copper, Zinc		
Bronze	Copper, Tin		
Steel	Iron, Carbon		
Pewter	Lead, Antimony, Bismuth, Silver		
Stainless Steel	Iron, Carbon, Chromium		

9. There are three types of steel; mild steel, medium steel and high carbon steel. Use the Internet to research the uses and properties of steel. What causes the differences in properties among the three types?