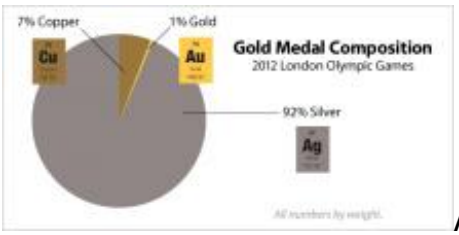
Are Gold Medals Really Gold?

In honor of the 2012 summer Olympics in London [1], we've decided to investigate a question commonly asked during the Olympics: are gold medals *really* made of gold?

The answer? Well, yes, they are … sort of.

Gold medals given to victorious athletes in the London Olympics do contain *some* gold, but they are not *solid* gold. In fact, solid gold medals have not been awarded to Olympic medalists since 1912.



As you might suspect, solid gold medals are not used because they would be too expensive. The gold medals awarded this year have a weight of 400 grams, which is about as heavy as a can of baked beans. If it were made of solid gold, it would cost about $22,429.89 to make! Then, if you consider that hundreds of gold medals will be awarded, the cost would easily be in the millions of dollars for gold medals alone!

Instead, to save money, the gold medals awarded this year will be mostly silver (92%) which is coated with only 6 grams of gold (about 1%). The remainder is copper (about 7%).

The process of coating one metal with another is sometimes referred to as "gilding". More specifically, when something is coated with a fine layer of gold it is said to be "gold plated".

Gold plating falls into a field of chemistry known as *electrochemistry*. Electrochemistry deals with chemical changes produced by electric current (like gold plating) or with the production of electricity through chemical reactions (like batteries).

To make a gold-plated Olympic medal, a chunk of silver is first plated with copper. Then, the copper-plated silver medal is plated again with gold. Silver is first plated with a thin layer of copper because copper acts as a barrier that will prevent gold from "diffusing" into the silver. If silver were directly plated with gold, some of the atoms of gold would "diffuse" or mix into the silver metal much more quickly. This would cause the metal to lose some of its luster and probably disappoint the Olympian who trained so diligently to earn it. So, copper is used as a "diffusion barrier" to help prevent some of this unwanted metal mixing.

The actual process of copper plating is done by placing the chunk of silver along with some pure copper in a special solution called an "electrolyte". Electrolytes are solutions that can

conduct electricity because they contain dissolved ions. A copper (II) sulfate solution is one example of an electrolyte. It contains copper (II) ions (Cu^{2+}) and sulfate ions (SO_4^{2-}). When the silver chunk and a piece of pure copper are placed in a solution of copper (II) sulfate, and a source of energy is added (like a battery), two simultaneous chemical reactions take place that result in copper metal being deposited or "plated" on the chunk o' silver.

The chemical reactions taking place that result in copper-plating (or gold-plating) fall into a category known as *oxidation and reduction reactions*, sometimes also called *redox reactions*. In redox reactions, the transfer of electrons from one source to another is categorized as either *oxidation*—when electrons are "lost"—or as *reduction*—when electrons are "gained". To keep track of all of these crazy electron shenanigans, chemists assign something called "oxidation numbers" that help them keep track of the flow of electrons in a redox reaction. In our copper-plating example, the chunk of silver being plated is gaining electrons (and therefore being reduced), while the pure piece of copper is losing electrons (and therefore being oxidized).

If you completed Chapter 4, Lesson 4 of Middle School Chemistry [2] then you observed another redox reaction, in which electrons flowed from one pencil to another, both of which were connected to a battery and submerged in water.

Don't worry if this seems confusing. The main thing to keep in mind is that electrons are flowing from one source to another, and as a result, copper (or gold) can plated onto a chunk of silver placed inside a special electrolyte solution.

Despite all of this, everybody still calls a gold-plated medal a *gold* medal. I guess you could say it's because it sounds better than an electrochemically copper-plated gold-plated silver medal!

You can learn more about how the Olympic medals for the 2012 London games were made in the video below.

Adam M. Boyd is a Sr. Education Associate in the office of K–8 science at the American Chemical Society. In his work at ACS, Adam focuses on chemistry, writing, and the web.

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