Is Gold Always Gold?

The Reaction:

$Au^{+3}_{(aq)\ [From\ HAuCl_4]}$ + citrate ions$_{(aq)}$ ---> $Au^{0}_{(s)}$

The gold that forms consists of nanoparticles (clusters of gold atoms) that are 13 nm in diameter!

These clusters do not get any bigger because they are surrounded by excess negative citrate ions. These ions help to repel the nanoparticles from each other.

http://mrsec.wisc.edu/Edetc/nanolab/gold/index.html

Question #1:

Arrange the following "objects" in order of decreasing size:

Thickness of human hair

Gold nanoparticle

Ebola virus

Red Blood Cell

http://www.purestcolloids.com/mesoworld.htm

Question #2:

Assuming that the gold nanoparticle is a perfect sphere, how many gold atoms are in this nanoparticle?

The gold nanoparticle is 13 nm in diameter.

The diameter of a gold atom is 0.288 nm.

Question #3:

How tall would **YOU** be if **ALL** atoms were magnified so that a gold atom’s new diameter was 1.0 cm?

Remember that the diameter of a gold atom is 0.288 nm.

Question #4:

The red color produced in the solution is due to the presence of the gold nanoparticles.

Since these particles are so small, how do we know that they are actually there?

Question #5:

Isn’t gold supposed to look gold?

Suggest a reason for why the gold in the solution appears red.

So why DOES the gold look red?

What is color?

For many objects, their color depends on which wavelengths of light are *reflected* and *absorbed* by the object’s atoms or molecules.

For example, a red object is good at *reflecting* red wavelengths of visible light (and good at *absorbing* all of the other wavelengths of visible light).

So why DOES the gold look red?

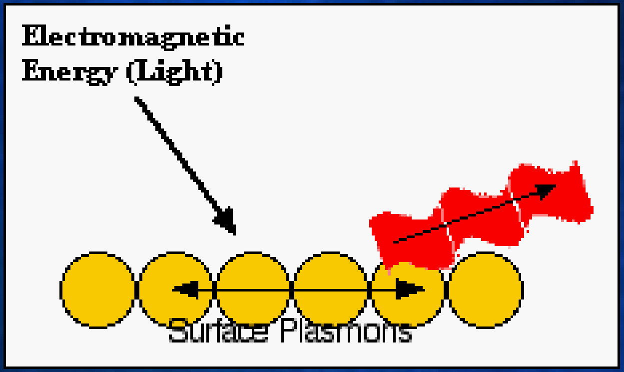
BUT - scientists think that a totally different process happens when light interacts with *nanoparticles!*

It's called ***surface plasmonics***.

So why DOES the gold look red?

BUT:

When nanoscale-sized clusters of gold atoms are hit with light energy, the surface atoms' free electrons begin to "slosh" back and forth and create electrons waves called *surface plasmons*.



THEN, these electron waves produce light energy which is released.

The color of the light produced depends on the size and shape of the nanocluster.

Question #6:

Why does adding NaCl(aq) to the gold nanoparticle solution produce a different result from adding $C_{12}H_{22}O_{11}$(aq)?

Question #7:

How might the ability of gold nanoparticles to change color be useful? What are some practical applications of this material?

Applications

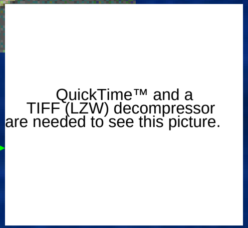
Gold ruby glass is a silicate glass containing well-dispersed nanometer size **gold** metal particles (less than 50 nm) giving the glass its distinctive red color.

http://www.physik.tu-muenchen.de/archaeometry/download/ICAMERuby.pdf

Applications

The Cup of Lycurgus (from 4th century A.D., currently housed in the British Museum) is an example of gold nanoparticles being used in glass from ancient history. When light shines through the glass, the charasteristic red color of gold nanoparticles can be seen.

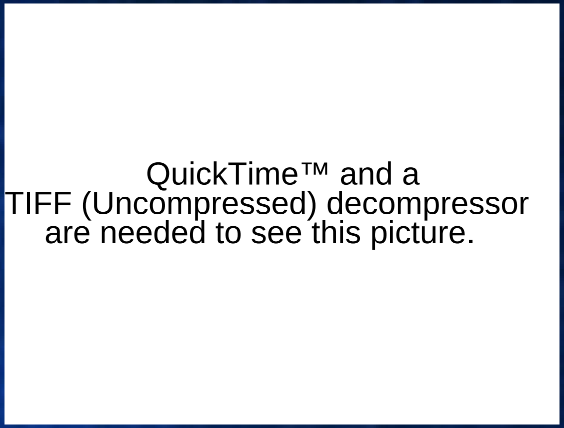
70 nm Gold nanoparticle



http://www.thebritishmuseum.ac.uk/science/lycurguscup/sr-lycugus-p1.html

Applications

This antique engraved Czechoslovakian glass is colored with silver nanoparticles (yellow in color) and gold nanoparticles (red in color).

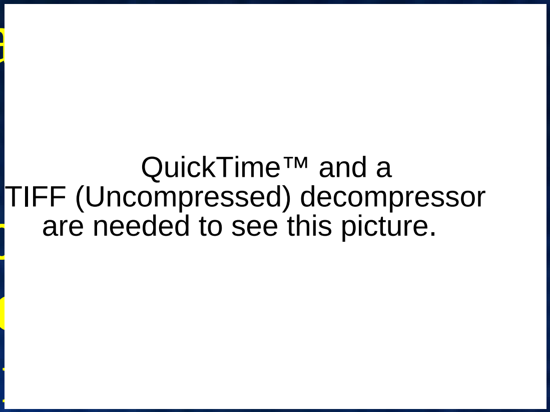


Yep, silver is not always silver in color!

http://webexhibits.org/causesofcolor/9.html

Applications

Nanoparticles of gold could soon be helping to spot viruses, bacteria toxins used by bio-terrorists.



Gold nanoparticles (16 nm) are co with various sugars used to dete specific toxins. The gold solutio but quickly changes to blue as the toxins bind to the sugars.

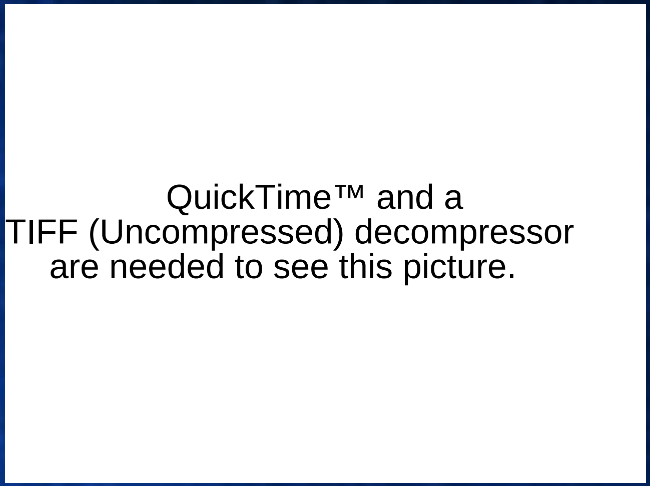
This color change can be used to detect the type and AMOUNT of toxin present!

http://news.bbc.co.uk/2/hi/technology/4872188.stm

Applications

Gold nanoparticle solutions could be used in detection systems to check for impurities in water (well below acceptable threshold limits) so we know if water is pure before we drink it.

Future research will focus on building the detection system into a portable device that can be taken out to places where poisonous substances are thought to be present.

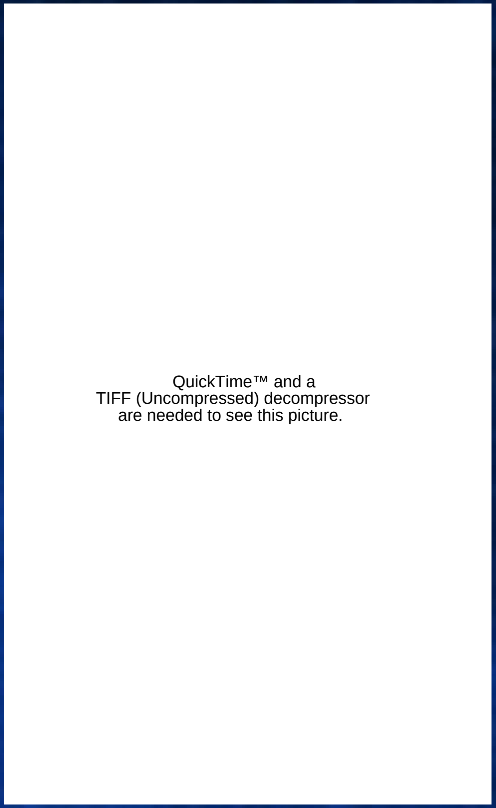


http://news.bbc.co.uk/2/hi/technology/4872188.stm

Applications

Many of the advanced applications of gold nanoparticles will require a regular arrangment of individual particles. How can we do that?

Scientists have created molecular grids using DNA in which 5 nm gold particles can attach to the grid in a regular arrangement.



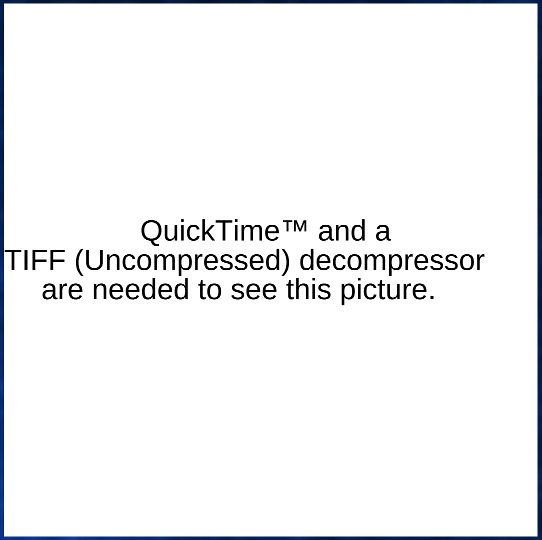
http://www.physorg.com/news11996.html

Applications

Gold nanoparticles may simplify cancer detection.

The gold nanoparticles will bind to the antibodies of cancer cells (but not healthy cells).

By shining light on a tissue sample, a simple microscope can then be used to detect the cancerous cells.



http://www.gatech.edu/news-room/release.php?id=561

Applications

When stimulated with the right frequency of laser light, a small collection of metal nanoparticles, such as gold, can heat an area up to 1,000 times its size.

In a biomedical application, a few gold nanoparticles could be used to generate heat to impact a single macro-scale object, such as a tumor cell.

QuickTime™ and a
TIFF (Uncompressed) decompressor
are needed to see this picture.

A cluster of gold nanoparticles 50 nanometers in diameter created a much larger crater in the ice sample, shown here. The cluster is represented in this image by a small black dot that is actually 100 times the actual size of the nanoparticles.

http://www.sciencedaily.com/releases/2006/03/060331102412.htm

Applications

Health Benefits?

There are many gold nanoparticle products on the market that claim to improve your health (mental focus, hand-eye coordination and creativity to name a few).

Whether or not these products actually can help improve your life is for **YOU** to decide!

http://www.purestcolloids.com/