Can the coloring effects of irradiated glass be reversed?

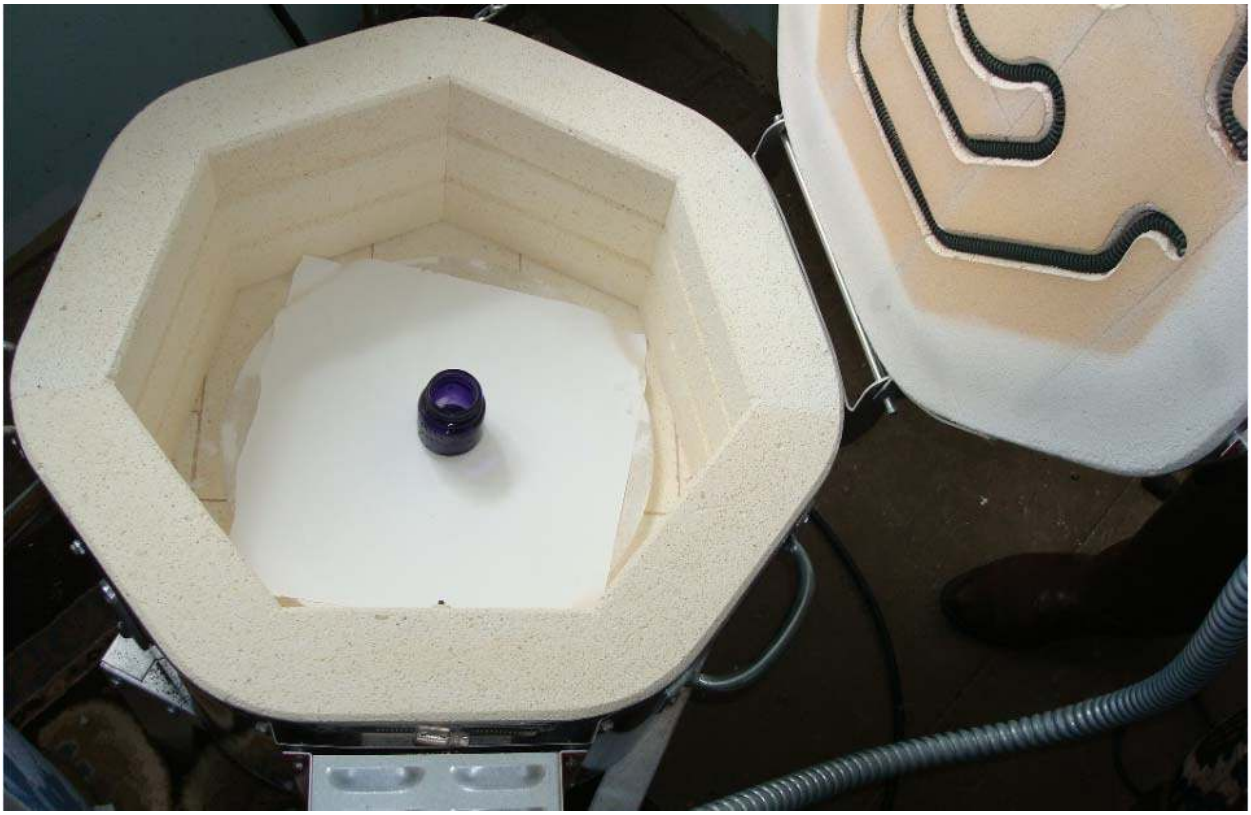
We know that the color of glass can be changed by exposing it to high energy radiation. Clear glass containing manganese will turn purple and clear glass containing selenium will turn a grey/amber. A number of sources have reported that this coloring effect can be reversed by exposing the glass to high temperature. Is this truth or myth?

We are not aware of anyone documenting this process. We will attempt to do an experiment and document the outcome. The first thing we need are some test subjects. Jim Eifler generously provided two sacrificial bottles. They are early 20th century machine blown Vaseline jars. One with manganese coloring (right) and one with selenium coloring (left). Both have been heavily irradiated, most likely from gamma radiation in s medical waste sterilization plant. The before photo is shown below.

According to various scientific sources the color change occurs when the high energy radiation forces electrons in the glass atoms to higher valence orbits. Since most of color reflection/refraction happens in these higher orbits color change can occur. The new electron orbits can be stable or metastable depending on the energy and the chemical composition of the

glass. Metastable changes may revert over time. Bringing the glass above its transition temperature (also known as the annealing temperature) should allow the energized electrons move back to more normal positions.

Now that we have some glass to test we need a way to get them really hot without destroying them. If we just use a torch the glass will heat and cool unevenly and stresses will destroy the glass. To heat and cool in a controlled manner we will use a glass kiln. Hobby kilns are used for making art glass items. It can ramp the temperature up , hold it, and take it back down so the glass wont experience thermal shock. Here we show the subject bottle in the kiln.



Next we have to make a couple assumptions. We will assume the glass is soda ash glass. That means it should have a transition point around 930F and a melting point at about 1500F. The trick is to bring the glass above the transition point (where the amorphous solid becomes a metal) but keep it below the melting point so we don't end up with a blob of glass. The melting point may be lower since we are re-melting pure glass. We decided to take the glass to 1100F to make sure we exceed the transition temperature. The kiln is programmed to ramp up to 1100F , hold for 15 minutes, ramp down to 700F (below the annealing point, then turn off. The temperature ramps up about 200F every 30 minutes. The kiln controller is shown here.

The kiln takes much longer to cool down than to heat up. It takes about half a day to treat a bottle but many can fit in the kiln at the same time. Below is a photo of the manganese bottle after heating. The bottle was turned back to its original clear color. So manganese irradiation changes are reversible.

Next the selenium bleached bottle was heated. Below is the final photo with both bottles. The amber/grey selenium glass is on the left. It turned it back clear with no trace of color.

We can conclude that irradiated glass can be restored to its original blown color by the act of re-annealing the glass.
This may prove useful in cases where rare bottles have recklessly been irradiated, for instance people who irradiate whole batches of glass not knowing what is common or rare. It can also restore items that have been color modified to perpetrate scams. An example of this would be irradiated Bromo Seltzers in odd colors.

A few interesting related questions have been asked. They will be answered here.

Q. Will a naturally sun colored amethyst (SCA) bottle turn back to clear?
A. Yes, since the UVB from the sun is causing the same effect as the man-made radiation.

Q. Will odd colored (non-irradiated) bottles changed color?
A. No, since they are the color that they were after the first annealing , a second annealing won't affect the glass color.

Q. Will a microwave do anything to a bottle?
A. Not if the bottle is below the transition temperature when you put it in the microwave. If it is above that temperature then either the microwave will burn up or the bottle will start melting since the microwave will see it as a metal object.

Q. Is it safe to re-anneal early 19th century glass?

A. Not in many cases. If the glass contains cracks, potstones, annealing fractures or stresses, bruises, etc, the reheating could cause stresses that a bottle wouldn't survive.