

Orange Glow Cell

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This experiment is mainly interesting because it produced an orange glow not seen before in this kind of cell. Typically, Aluminum electrodes produce a blue green or mint green hue in dilute H₂O electrolytes.

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A cell with two aluminum sheet metal (roofing flashing) electrodes about 1/4" wide and 6" long were conditioned over 4.5 hours until reaching 106.6 V RMS full wave DC and 1.7 mA. The electrolyte was 350 ml of distilled water with 1/4 teaspoon baking soda. The anode glow was green and could be seen in a dimly lit room.

To try shock conditioning the electrode the voltage was pushed up to 162 V and the current there was 20 mA but fell in a minute to 9.1 mA. The glow increased significantly, but the color took on a light pastel orange hue. The current was dropping rapidly, so the cell was in a fast conditioning mode of some kind.

After another minute the voltage was manually reduced to 93 V and the current went way down to 0.1 A. There was no visible glow. The voltage was raised to 134 V and the current was 1.0 mA and there was a slight green glow.

The current surge did shock condition the cell in the sense of giving it good resistance characteristics, but apparently negatively affected the glow characteristics. It reduced the glow for a given voltage. The glow was visibly more at 106.6 V, 1.7 mA than it was later at 134 V, 1.0 mA. The glow intensity appears to be principally a function of current.

The cell was left off overnight.

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The cell was restarted at 152 V and 1.1 mA. Conditioning continued to 163 V at 1.2 mA in 2 h 34 min. The glow, which was dim, remained orange. At this time the cell was pushed to 179 V at 3.2 mA to increase brightness to take a photo. A photo, Photo 1, was taken in a dark room. The photo exposure time was 8 seconds, and the (virtual) ASA was set at 800. Right before, and at the same tripod position, Photo 2 was taken to show electrode positions. The glowing electrode was the anode. Photos 1 and 2 shown together below for comparison purposes.

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Photo 1 - Orange glow anode 179 V, 3.2 mA



Photo 2 - Same as Photo 1 with lights on, no current

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The orange color might have involved oxidation or destruction of some of the surface nano-structure. Whatever produced the orange hue also reduced the light intensity created by the electrode for a given current. The low intensity orange glow did not go away after 2.5 hours of subsequent conditioning, so the anode surface condition may be permanent.

One speculation is that the orange glow involves carbon in some way. Heated carbon can glow orange. The NaHCO₃ electrolyte contains carbon. There was very little bubble formation when running at high current (3.2 mA) but there was an acrid smell near the cell.

It is especially noteworthy that at no time were the electrodes not shiny. They remained as shown in Photo 1 throughout the approximately 7 hours of operation, with the exception that bubbles formed on the electrodes initially. Bubbles seldom broke loose from the electrodes after the first hour of conditioning. Before taking Photo 1, the electrodes were shaken to remove the bubbles, so as not to have a mottled look to the anode in the photo due to the bubbles.

The cell was restarted for about 2 hours and in that time bubbles formed on the cathode, but not significantly on the anode. Something is suppressing oxygen evolution at the anode.

After some discussion with colleagues I am now convinced the orange glow is merely due to red spot arcs as observed and described early on, but much smaller. The spots are due to loss of conditioning in very tiny areas.

Upon too large a surge current, the conditioned film, especially if it is thin or non-uniform, is perforated in many places, forming very small arc spots. The spots are initiated due to loss of conditioning in very tiny areas plus running a high enough voltage to sustain them. As the arcs persist they burrow small pits on the anode surface, which are visible by optical microscope. The arc spot areas are so small and so ubiquitous that the color of their red arcs mixes with the green to make a kind of orange. They are tiny, but still very effective at eating up the anode, however. This means an orange hue is very bad, an indication that conditioning has to occur at a lower voltage, or possibly that (re)conditioning is not possible without removing the existing film, due to the inability of the electrolyte to get to the bottom of the tiny arc

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spots due to bubble formation.

Conditioning takes a lot a patience. It is becoming clear that a constant current power supply may be very useful for conditioning, at least in a commercial environment. It could essentially implement the conditioning algorithm except possibly for the occasional need to change the current and/or the electrolyte.