

2018-11-27 Unconventional electrolysis

can

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1. Experimental notes

- Materials and setup
 - Two anodized ferromagnetic steel pieces
 - Will use 5V
 - Open glass jar
 - Electrolyte
 - Mainly K_2CO_3 solution in deionized water, added in water Q.B.
 - Partially KOH (0.5M solution left from previous experiment)
 - To refill evaporated water

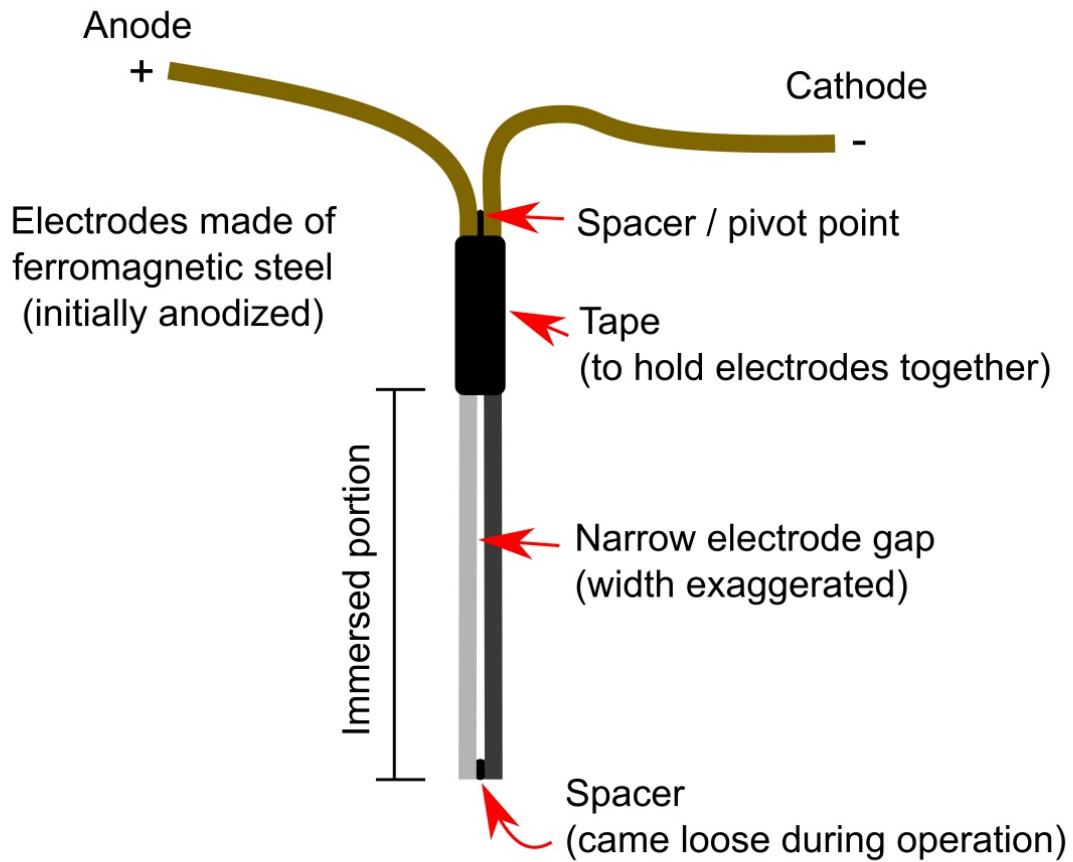


Figure 1.1: Principle of the experiment.

- <14:16> Experiment started
 - 5.06V (very low load)
- <14:18> Added very weak magnet near cathode
- <14:19> AM radio sometimes fizzes
- <14:20> Reversed electrode polarity
 - 5.14V
 - PSU load now even lower
- <14:21> Added some K_2CO_3 electrolyte
 - 5.09V
- <14:27> Added a much larger amount of K_2CO_3 electrolyte
 - Very roughly a few grams of electrolyte in 25 grams of water?
 - It looks like it will take a while to dissolve
 - 4.97V

- <14:29> 4.93V
 - Cell now slightly warm
- <14:30> 4.92V
 - Experiment paused
- <14:38> Experiment resumed
 - 4.89V
- <14:39> 4.85V
- <14:42> 4.77V
 - When the cell is powered the AM radio makes a different noise
- <14:45> Tried inverting electrode polarity manually
 - Troubles achieving conduction. It seems to be a wire problem (oxidized terminals)
 - **From this point the cathode will remain the high electrode (right side)**
- <14:48> 4.57V
- <14:49> 4.46V (decreasing)
- <14:50> 4.38V
 - Experiment paused
 - I thought the load was too high
- <14:53> Experiment resumed
 - The anode wire seems to be overheating
- <14:55> Manual power application (instead of leaving the wires clamped)
 - 4.13V seen, peaked below 4V
- <15:00> **Strange condition: initially the electrodes appear as if they are short-circuiting, but by persisting eventually proper conduction/electrolysis is re-established. this mostly occurs after power is temporarily removed**
- <15:03> Temporarily lifting the electrodes from the electrolyte solution restored the situation
 - The anode looks clear&clean, cathode looks black
- <15:07> Still problems, but they can be recovered early
 - Cathode seems more magnetic than before? **Update:** probably not
 - The anode wire is the one which overheats
- <15:25> Experiment paused
- <15:35> Experiment resumed
- <15:46> Prolonged operation at about 4V, high PSU load
- <15:48> Placed a piece of paper that I previously placed on top of the cell (to avoid splashing electrolyte solution around) in front of the Geiger counter, at a very close distance to the GM tube (aka JohnnyFive test)
 - No apparent result observed
- <16:08> Stripped the wire terminal of its oxidized end and applied 5V power

- Peaking below 4V
- <16:09> Placed large magnet at a distance from the cathode such that if the magnetic field increase just slightly, it will end up getting attracted to it
- <16:15> The magnet did not move at a distance
 - Placing it on the jar
- <16:19> With the magnet in place it does not seem to be shorting anymore, but could be just luck
 - Now placing a small magnet pile in its place
- <16:20> Noticing that electrolysis appears to be going on at a low rate by itself
 - Either this or gas is being evolved by the cathode for some reason
- <16:25> Sometimes a moderate click sound is heard from the cell
- <16:29> Attempting to measure voltage difference between electrodes
 - 660 mV? Varies, for some reason it's difficult to measure
- <16:30> Applying 5V again
- <16:33> Kept applied until a short-circuit condition was reached
 - ~4V continuous
 - Peaked 2.65v Strange sucking noise heard when this happened
 - After this, clicking sound from the cell when powered off
- <16:35> Trying again
- <16:38> Conducted for long time at 5V
 - Effective voltage ~4.1V



Figure 1.2: The electrode assembly. The gap does not have a fixed width; the assembly is "floating".

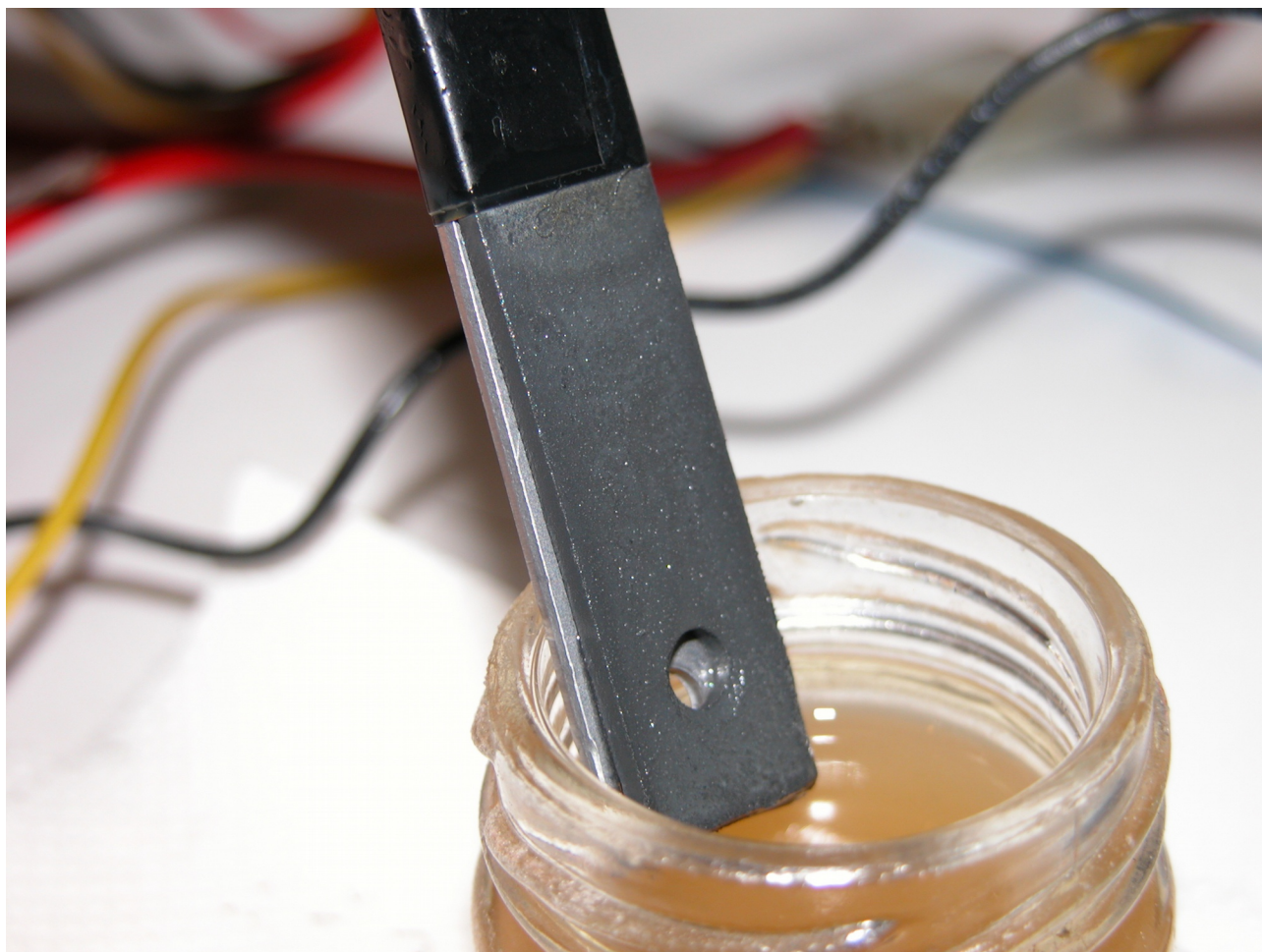


Figure 1.3: A front view of the cathode. Protuberances grew on its surface.



Figure 1.4: The backside of the anode. Looks smooth from here.

- <16:50> Several runs at 4.10~4.25V
 - Again click sounds heard when power is removed. They occur at a rate of one every several seconds, it seems relatively regular.
- <17:03> Noticed that the bottom spacer came off of the electrode assembly. How does it keep working?
 - **Probable explanation:** when a short circuit occurs, a spot on the electrodes heats up considerably, perhaps close to the melting point of the material. The strong heating causes the formation of gas bubbles large enough to separate the electrodes so that normal operation (electrolysis-cavitation) can continue. This requires the power supply and the wires to be able to provide and sustain a large current



Figure 1.5: The cathode after a longer period of operation.



Figure 1.6: The anode still looks smooth.

- <17:10> Trying again
- <17:21> The main insulating part came loose and now it's difficult to achieve proper conduction
 - I think I've seen enough for today, turning off
 - Saving the electrolyte for later use
 - Experiment terminated



Figure 1.7: The entire electrode assembly after usage.

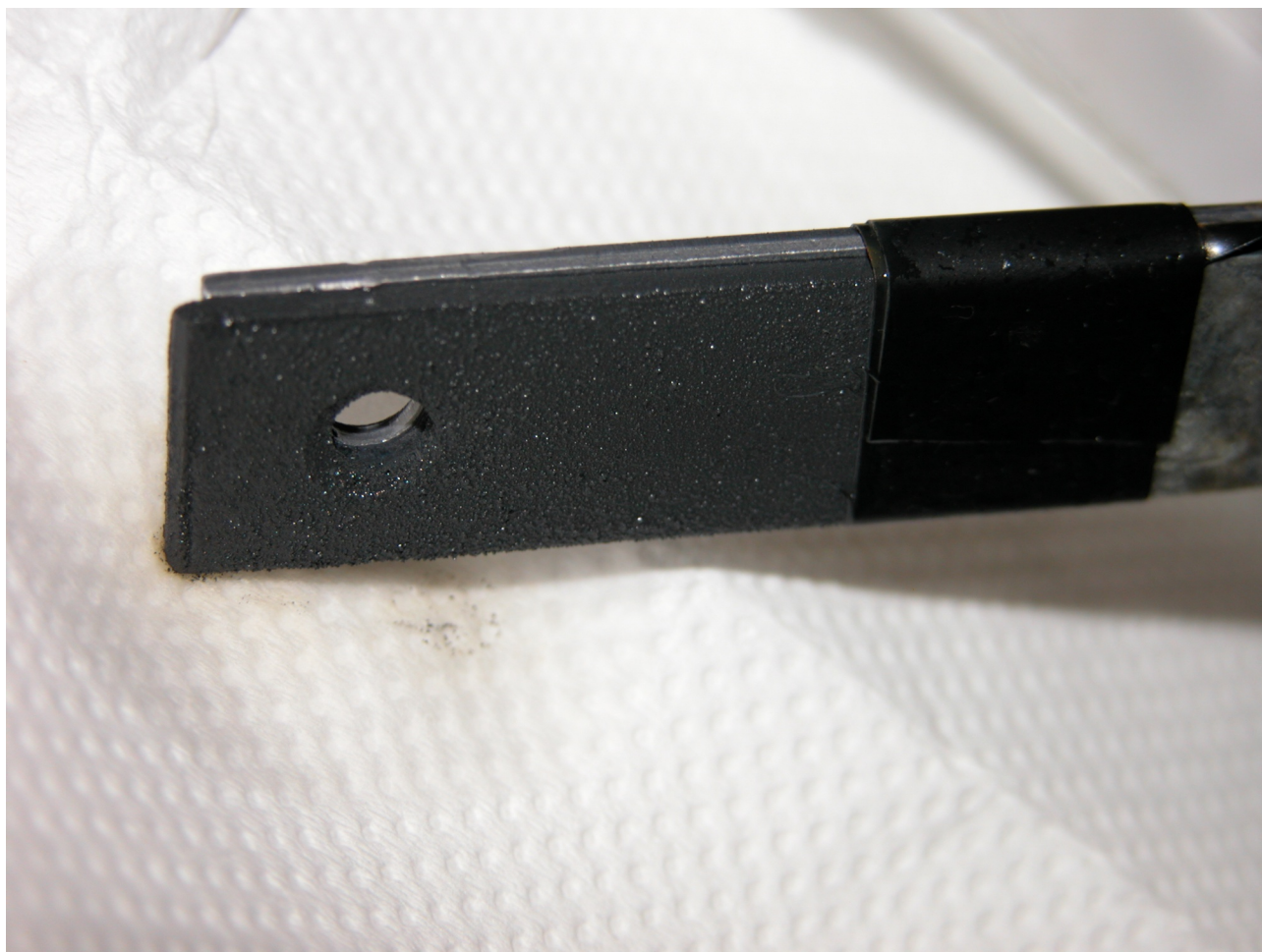


Figure 1.8: A closer look at the cathode.

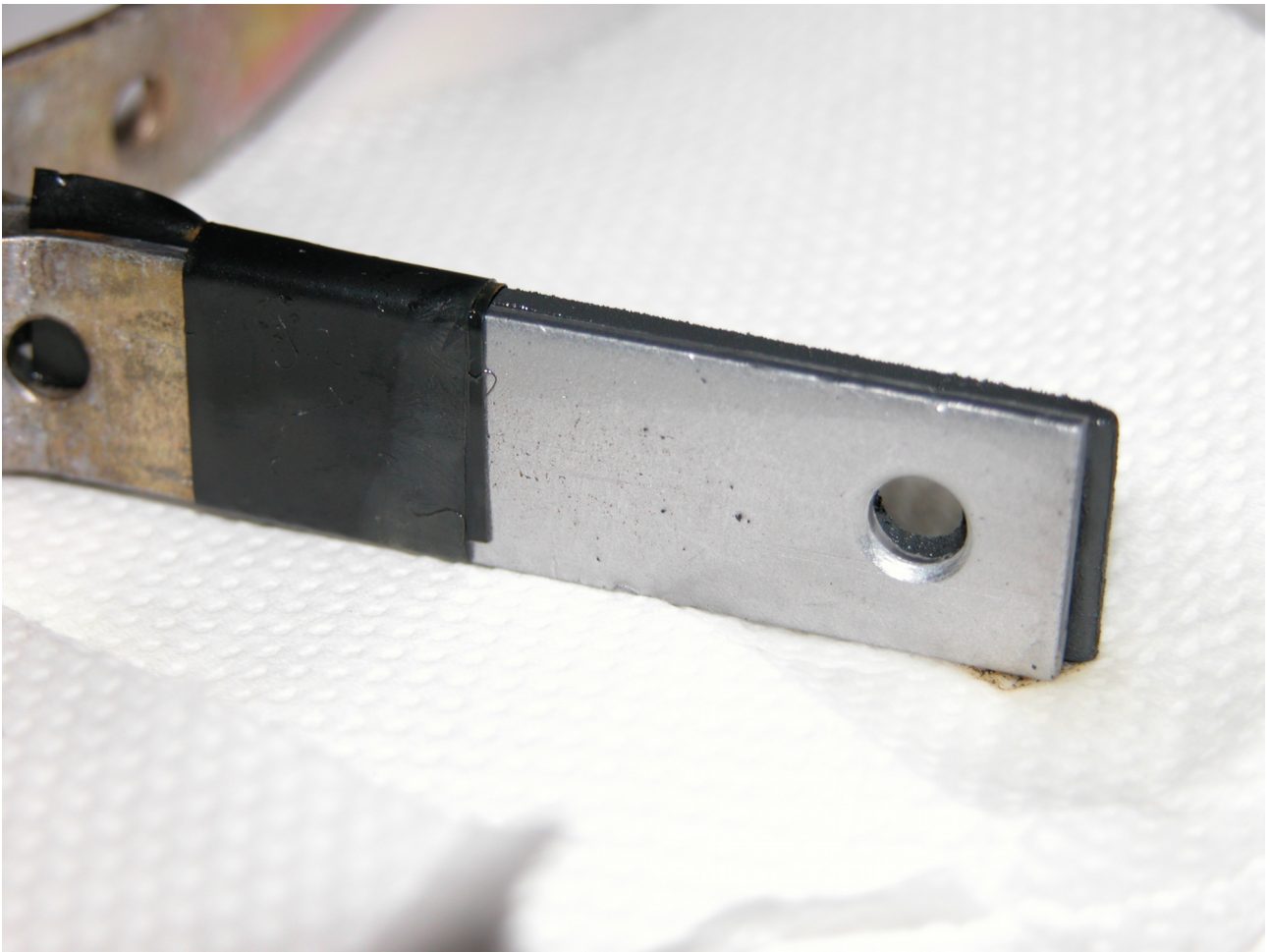


Figure 1.9: The anode is again smooth from this side.

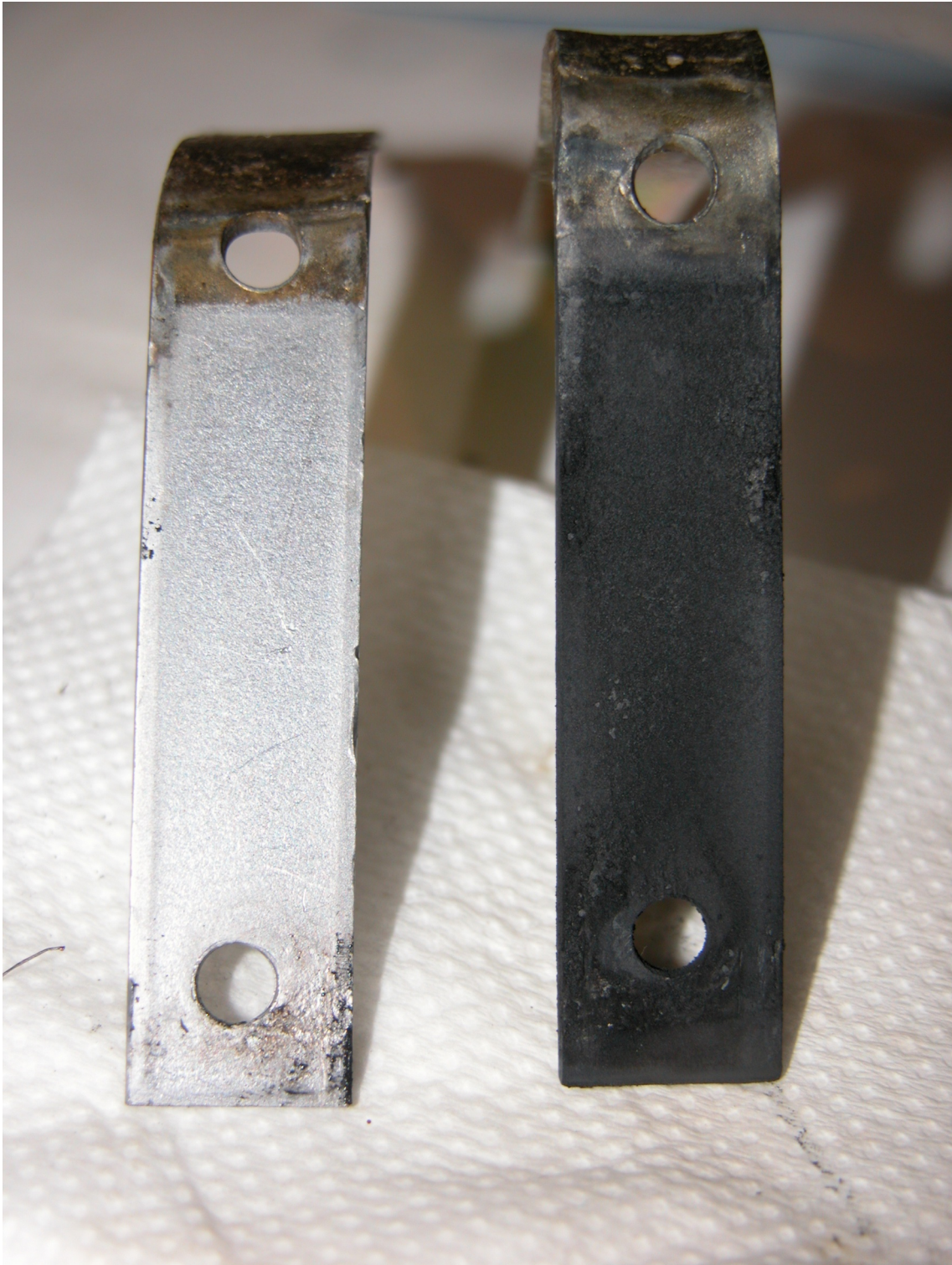


Figure 1.10: The electrodes at the interface. The anode especially appears to show extensive cavitation damage.

- <17:35> Put pieces on low temperature USB heater
- <19:40> Performed a methane flame heating test on the blackened cathode, but that did not result in any particular reaction at the Geiger counter
 - On the other hand, about 45 seconds passed from heating it and placing it near the GM tube and possibly there might have been something emitted in real time

- I got the impression that it did not heat up as much as it should have compared to the an iron oxide/rust electrode assembly I tested earlier on

2. TODO Observations

- I wanted to produce rust, but no rust was formed
- Anode clean and pretty much oxide-free, contrarily to expectations, but similar to initial observations during early experiments
- Cathode turned dark black
- The anodized finish got quickly removed as expected