

# Oxhydroelectric Effect: Electricity from Water by Twin Electrodes

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**Abstract.** Electricity extraction from water by twin electrodes, mediated by oxygen molecules, that we call Oxhydroelectric Effect, is reported. The extremely simple components of this experimental system are: two platinum (*Pt*) wire electrodes, a saturated solution of potassium carbonate ( $K_2CO_3$ ) in water ( $H_2O$ ) (with pH >10) as electrolyte, and a film of hydrophilic material (Nafion®). A dc power of the order of hundredths of nW was measured for days through a resistor connected to the twin *Pt* electrodes. The addition of a very small amount of hydrogen peroxide ( $H_2O_2$ ) to the electrolyte (water-potassium carbonate solution with only 0.004%  $H_2O_2$ ), as a source of oxygen, determines an immediate dc power jump, more than two orders of magnitude high, lasting for days. The Oxhydroelectric Effect opens the way to a completely new paradigm in what concern low-cost electrical energy generating systems, with a tremendously wide range of possible applications.

## Introduction

The experimental evidence of electricity extraction from water by twin electrodes mediated by oxygen molecules, that we report in this paper, is an astonishing phenomenon in the frame of the classical electrochemistry. Nevertheless, we will show that it has a theoretical background in the modern quantum electrodynamic (QED) description of water.

The seminal works of G. Preparata and E. Del Giudice [1,2] have described the liquid water structure by an *ab initio* quantum field (QED) theoretical approach. From these QED calculations results that liquid water has a peculiar structure consisting of a mixture of coherent and non-coherent phases, in amounts depending on temperature. In particular, liquid water appears to be a matrix of “gaseous” water including many “Coherence Domains” (CDs), about 0.1  $\mu\text{m}$  in size, in which all water molecules oscillate in phase with a self-trapped electromagnetic field. The water coherent oscillation occurs between the fundamental state, where molecules keep their own electrons tightly bound (ionization energy of 12.60 eV) and an excited state, where one electron is quasi-free. Considering that the energy of the excited state was calculated to be 12.06 eV, a small amount of energy as  $(12.60 - 12.06) \text{ eV} = 0.54 \text{ eV}$  is enough to release an electron. The coherent water, unlike “gaseous” non-coherent water, is a reservoir of quasi-free electrons that can be easily released outwards, either by quantum tunnel effect or by small perturbation, inducing electronic excitations in the non-coherent molecules surrounding the CDs. If we should be able to separate the coherent from the non-coherent water, we can get a battery where the coherent water represents the negative pole and the non-coherent water is the positive pole. In normal water this condition is rarely fulfilled because an electron leaving a CD may end up in another CD. The required separation occurs at the water interface with membranes, hydrophilic surfaces, microspheres, etc. In fact, in the last few years, G.H. Pollack and his collaborators have reported the existence of extended regions at the boundary between liquid water and a hydrophilic surface, called Exclusion Zones, (EZs), where the dyes dissolved in water cannot enter [3-5]. The depth of these EZs can reach some hundreds of microns, much wider than the classical theoretical predictions. The peculiar properties of the water from the EZs are: higher viscosity than bulk water (about tenfold); negative electric potential (up to 150 mV) with respect to the neighboring bulk water; protons concentration

at the boundary between EZs-water and bulk water; peak of light absorption at 270 nm; fluorescent when excited by 270 nm wavelength light; IR irradiation increases the depth of the EZs layer; cannot host solutes.

The existence of EZ water represents an experimental confirmation of the coherent water prediction based on QED principles, considering that the attractive interactions between the water molecules and the hydrophilic material assure the stabilization of the interfacial water CDs, protecting them from external thermal collisions. Consequently, the interfacial water becomes extensively ordered, being almost completely coherent, so that the interface between the fully coherent water and the bulk water becomes a red-ox pile.

Another very interesting experimental evidence of the water CDs has been reported by V. Voeikov et al. [6] who showed that hermetically closed water bicarbonate solutions with 0.0005%  $H_2O_2$  emit photons for many months, even in complete darkness. It is therefore evident that water-bicarbonate systems can reside in a stable non-equilibrium state, acting as a permanent source of “free energy”. The reducer that can supply red-ox reactions is the Coherence Domain itself. The release of electrons can occur through the quantum tunnel effect; the almost free electrons should cross an energy barrier of  $(0.54 - X)$  eV, where X is  $\sim 0.1$  eV, owing to the electric potential difference at the CD boundary with the bulk water. The  $\sim 0.44$  eV energy coincides with the electro-negativity of the  $O_2$  molecule that is the privileged receptor of the electrons tunneling out of CDs [7].

The above mentioned theoretical and experimental data evidence that the water CDs collect low grade (high entropy) energy from the environment transforming it into high grade (low entropy) energy able to perform external work. The aim of our research is to use this kind of mechanism to put the basis of a completely new class of electric energy generating systems, without the need of any nano- nor micro-technology: there is plenty of room around here. We report electric energy extraction from water by twin electrodes mediated by oxygen molecules, replicating the Pollack experiments in a different experimental configuration of the cell, and without IR irradiation. But the principal aim of this work is to experimentally verify the theoretical prediction concerning the fundamental role of the  $O_2$  molecules in electrons extraction from the water CDs.

### Experimental set-up

The scheme of the experimental arrangement used to extract electricity from water by twin electrodes is shown in Fig. 1.

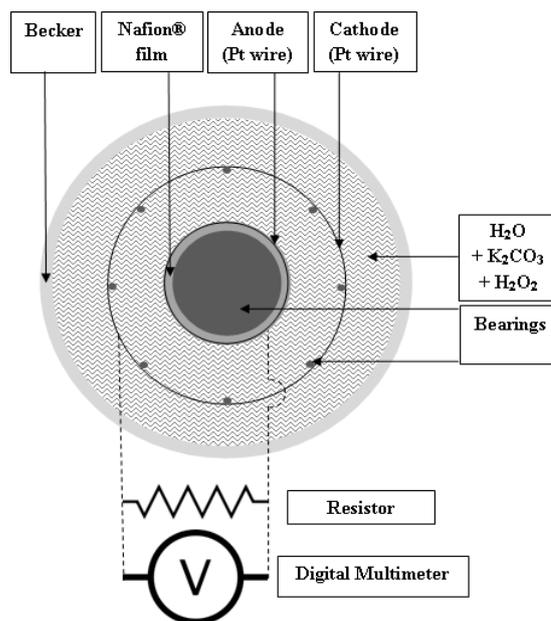
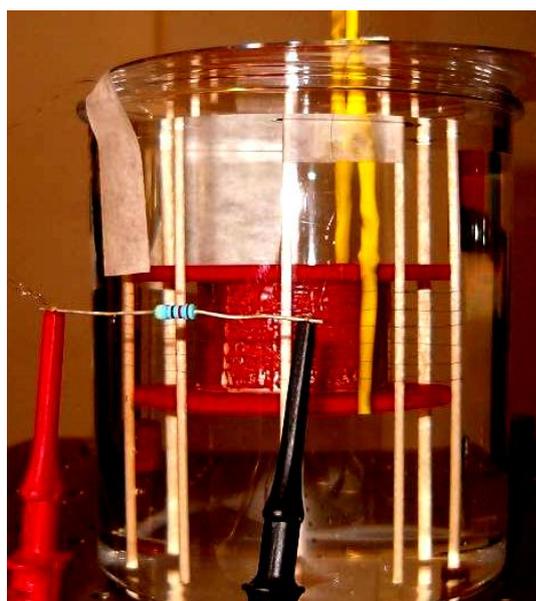


Fig. 1 Experimental set-up of the cell with twin *Pt* electrodes: (a) photo, (b) transversal section scheme. The simplicity of the experimental set-up is evident.

The system consists of a transparent plastic beaker (11 cm diameter, 13 cm high, and about 450 ml capacity), inside which a cylindrical symmetry anode-cathode structure was positioned. The inner electrode was the anode, made of a platinum wire (*Pt*, Laborplatina 99,95 % purity, 0.1 diameter) tightly coiled (6 rounds, 5 mm spaced) around a strongly hydrophilic material, Nafion® film (0.2 mm thick), glued on the external surface of a plastic bobbin (3.5 cm high, 1.5 cm core diameter, 5 cm bases diameter) used as anode-cathode holder (Fig. 1). The outer electrode, the cathode, made of an identical *Pt* wire, was coiled and fixed around a bearing structure consisting of thin wooden sticks glued on the bobbin flanges (Fig. 1). The anode-cathode radial distance was about 2 cm. The electrolyte was a saturated solution of potassium carbonate ( $K_2CO_3$ ) analytical-grade (Farmalabor) in water ( $H_2O$ ), providing a strongly alkaline background (pH >10). A 47 k $\Omega$  resistor was connected to the twin *Pt* electrodes, and a Digital Multimeter 6 ½ digit Agilent 34401A was used to measure the voltage across the resistor. A versatile LabVIEW™ software was specifically developed for data acquisition and on-line monitoring of the phenomenon for many weeks. This is all, without need of any nano- and not even micro- technology: there is plenty of room around here.

### Experimental results

The on-line monitoring of the electric current generated by water and flowing through the resistor shows a current dependence on the temperature conditions (infrared radiations, room heat) of the laboratory, and also a general decay of the phenomenon in time, in agreement with Pollack results. The cell generates a dc power of the order of hundredths of nW, lasting for several days. Several experimental tests showed that adding a very small amount of  $H_2O_2$  to the electrolyte (0.004%  $H_2O_2$  in the electrolyte) during stationary condition of constant voltage vs. time, determines an increment of the electrical power of more than two orders of magnitude. We call this Oxhydroelectric Effect. A typical behavior of the voltage vs. time before, during and after the oxygen addition is shown in Fig. 2, where an increase from 0.038 nW to 14.60 nW is measured in the short time of 8 seconds from the  $H_2O_2$  addition, and incrementing in a few minutes up to 16.14 nW. This power magnitude was lasting for several days (about 1 week) before decaying to the initial values (lack of oxygen), with some daily variations depending on temperature conditions of the laboratory (room heat).

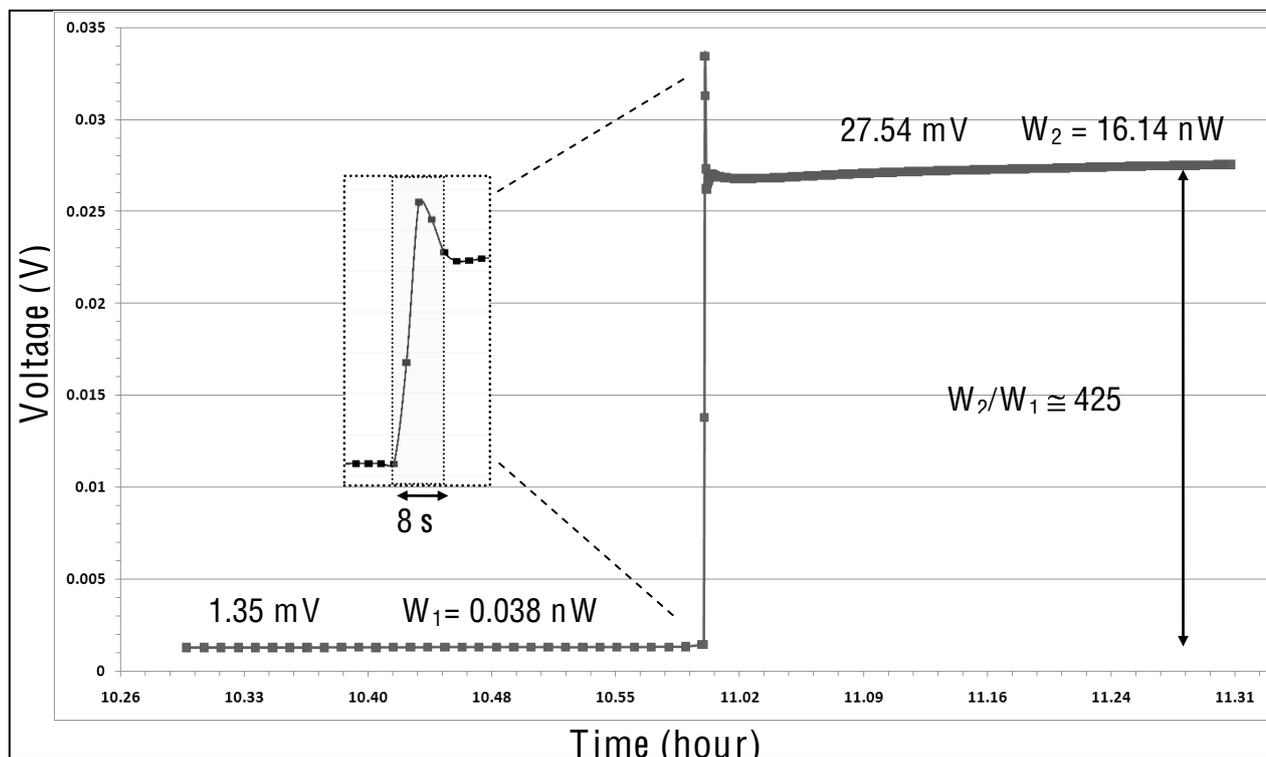


Fig. 2 DC voltage across the 47 k $\Omega$  resistor vs. time, before, during and after  $H_2O_2$  addition to the electrolyte. The electric power ratio  $W_2/W_1$  shows a jump more than two orders of magnitude.

## Conclusions

The experimental results confirm the theoretical prediction on the fundamental role of the oxygen molecules in electricity extraction from water by means of twin electrodes. In fact, as already said in the introduction, the almost free electrons of the Coherence Domains (CD) should cross an energy barrier of  $(0.54 - X)$  eV, where  $X$  is  $\sim 0.1$  eV, owing to the electric potential difference at the CD boundary with the bulk water, but the  $\sim 0.44$  eV energy coincides with the electro-negativity of the  $O_2$  molecule that is consequently the privileged receptor of the electrons tunneling out of CDs. This conceptual agreement with the theoretical prediction requires a thorough analytical investigation and much work is underway, but without any doubt, this research is confirming something very significant: water is a system staying in a stable non-equilibrium state due to co-existence of its two phases that have different thermodynamic parameters. One of the phases, that one closest to hydrophilic interfaces (“interfacial water” in biology language) is crowded by low entropy coherent domains (Exclusion Zone water) and the other is high entropy “bulk” water.

This double system can perform internal work to sustain its non-equilibrium state due to negentropy coming from the spontaneous conversion from non-coherent to coherent state, but the environment radiant energy (room heat) make the system reverting to its initial state and so on, like a real “microscopic engine”, that from many point of view is mimicking the Maxwell’s Demon of his famous Gedankenexperiment.

In this theoretical frame, it is clear that the Oxhydroelectric Effect opens the way to a totally new class of electric energy generating systems, able to transform directly low-grade energy (heat) to high-grade energy (electricity).

The progress in the promising and highly challenging research field on the peculiar coherent and non-coherent structure of the water, on the Oxhydroelectric Effect and on the extraordinary wide range of applications scattering from the understanding of the fundamental water mechanisms is intimately linked to the joint efforts of experimental and theoretical scientists moving beyond the actual paradigms in physics toward the understanding of the wide diffusion in nature of the low energy coherent systems.

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