

Oxhydroelectric Effect in Bi-Distilled Water

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Abstract. Oxhydroelectric Effect, that is the extraction of electricity from an aqueous electrolytic solution by twin Platinum (Pt) electrodes, mediated by oxygen molecules, has been detected for the first time in bi-distilled water (electric conductivity of 1.2 microSiemens/cm). A dc power of the order of tenths of microW, lasting for many hours, was measured through a resistor (47 kOhm) connected to twin Pt electrodes immersed into bi-distilled water, after the addition of some pieces of Nafion® in one semi-cell and of a very small amount of hydrogen peroxide (H₂O₂) - as a source of oxygen - in both semi-cells.

Introduction

Electricity extraction from bi-distilled water by twin electrodes reported in this work is an astonishing phenomenon in the frame of the classical electrochemistry because - considering the absence of any significant quantity of ionic solutes in this pure water system - it seems to imply some kind of “other than ionic” conduction. The unexpected phenomenon of electricity extraction from water by twin Platinum (Pt) electrodes, mediated by oxygen molecules, called Oxhydroelectric Effect, has been already observed in a “standard” electrolyte solution [1,2]. The new experimental configuration [3] described here, using bi-distilled water instead of water-electrolyte solution, has been conceived exploiting new physical concepts concerning pure water behavior, derived from numerous experimental results published elsewhere [4-12]. In a few words, these results demonstrate the variation of the physico-chemical properties of pure, bi-distilled water (such as significant changes in pH, density, UV-vis absorbance, light scattering, and mixing heat with alkaline or acid solutions) when subjected to some kind of physical treatments such as iterative agitations or filtrations, contact with hydrophilic surfaces, etc. For example, the electrical conductivity of the chemically pure water increases up to 300% after iterative filtrations [4,5,7]. These changes in the physical-chemical properties of the pure water are most likely to be attributed to variations in its supra-molecular structure, due to an extraordinary auto-organization potentiality, triggered by several kinds of small energy perturbations - that is the basis of every living system.

Experimental set-up

The experimental arrangement used to extract electricity from bi-distilled water by twin electrodes is shown in Fig. 1. The system consists of two L-shaped glass semi-cells (each of them of 2 cm in diameter, 7.5 cm in length and 10.5 cm high), connected among them and provided with a 25 nm filter Millipore® positioned at their junction.

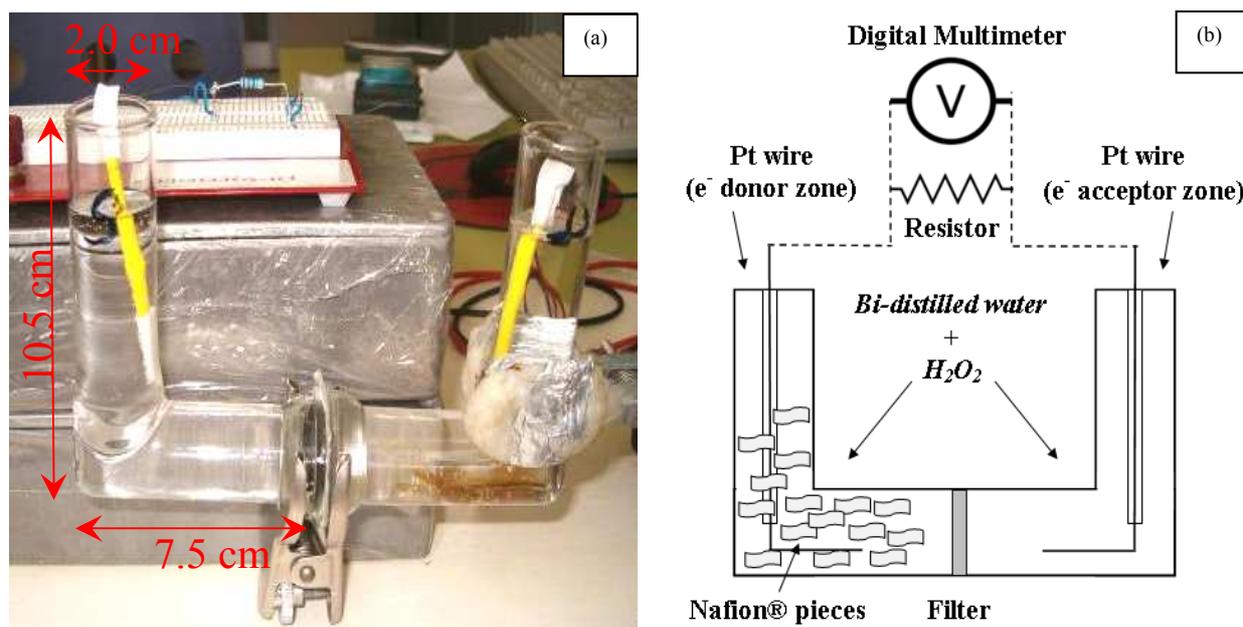


Fig. 1 Experimental set-up of the cell with twin Pt electrodes: photo (a) and schematic (b).

The semi-cells are filled with bi-distilled water, having an electric conductivity of 1.2 microSiemens/cm, and in each of them a platinum wire electrode (Pt, Laborplatina 99.95 % purity, 0.1 mm in diameter) is immersed. One of the semi-cells contains small pieces (about 20 square pieces of 5 mm side length and 0.2 mm thick) of Nafion®, a strong hydrophilic material. Both Pt electrodes are immersed in the “bulk” volume of the bi-distilled water, different from the “standard” Oxhydroelectric Effect [1,2] where the electrode in the semi-cell containing Nafion® is placed in the so called “exclusion zone” that is a micrometric region close to the hydrophilic surface [13-15]. A standard 47 kΩ resistor was connected to the Pt electrodes, and a Digital Multimeter 6½ digit Agilent 34401A was used to measure the voltage across the resistor, by means of a LabVIEW™ software specially developed for data acquisition and continuous monitoring of the phenomenon for days. The filter among the semi-cells has the function to confine the supra-molecular water structures generated in one semi-cell, originating in such a way a physical asymmetry among the two volumes of chemically pure water.

Experimental results

As expected, a negligible noise current was detected in the resistance when in the two semi-cells there was only pure water and the electrodes. The insertion of the Nafion® pieces in one semi-cell and the addition of a very small amount of hydrogen peroxide (H_2O_2) to the bi-distilled water - as a source of oxygen - determines an abrupt increase in the dc power trough the resistance. A typical behavior of the voltage vs. time before and after H_2O_2 addition (0.002wt% H_2O_2 in each semi-cell) is shown in Fig. 2(a). A jump of the dc power from zero to a plateau value of 0.03 microW (that lasts for many hours) is measured after only 15 seconds from the H_2O_2 addition. Subsequently, a further addition of H_2O_2 (0.002wt% H_2O_2 in each semi-cell) generates, during 19 seconds, another jump in the dc power up to 0.26 microW, as shown in Fig. 2(b). This power value was lasting for some days before decaying to the initial values, with some daily variations depending on the temperature conditions of the laboratory (room heat) – see Fig. 3. It is interesting to notice that the measured dc power extracted from the bi-distilled water is one order of magnitude higher than that reported for the “standard” Oxhydroelectric Effect obtained in standard water-electrolyte solution [1,2].

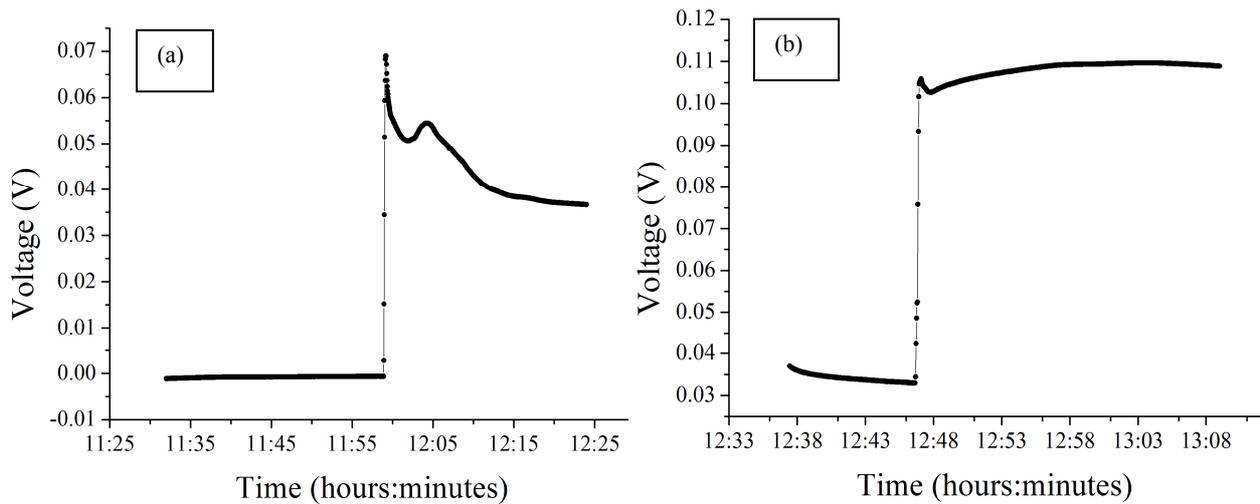


Fig. 2 Typical DC voltage across the resistor ($47\text{ k}\Omega$) vs. time, measured after the insertion of 18 Nafion[®] pieces in the bi-distilled water of one semi-cell, before and after the first (a), and the second (b) H_2O_2 addition to the bi-distilled water (0.002wt%) in each semi-cell (one experimental point every 2 s).

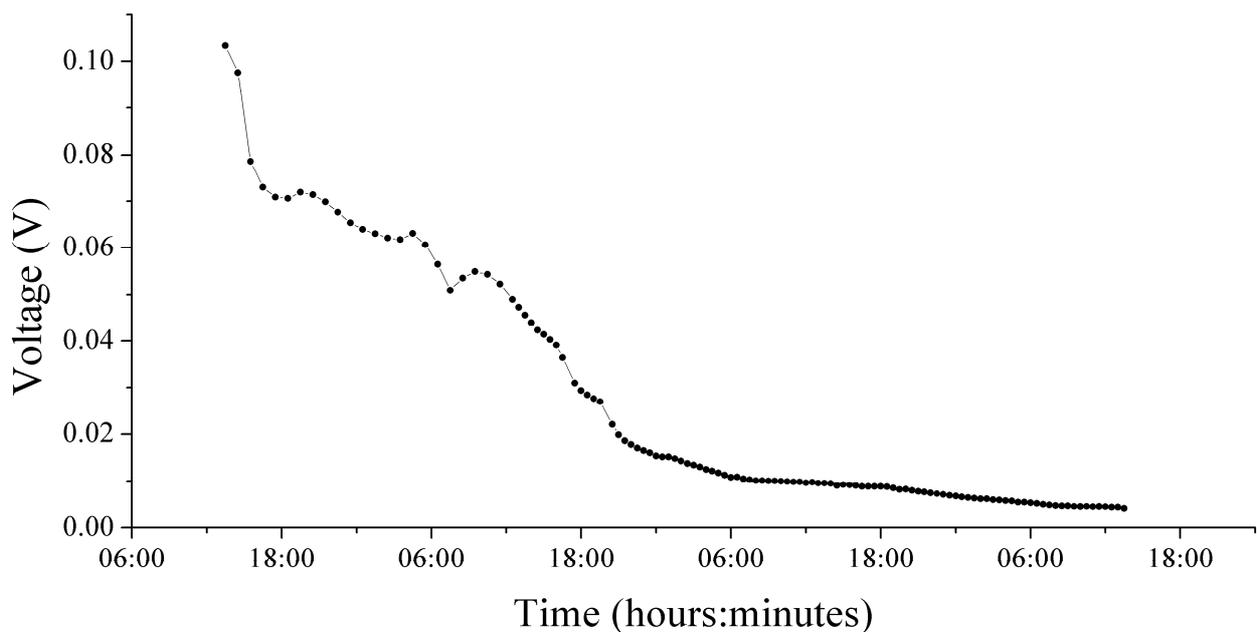


Fig. 3 DC voltage across the resistor ($47\text{ k}\Omega$) vs. time during 4 days monitoring (one experimental point every 30 minutes).

We measured that adding electrolytes - such as K_2CO_3 - the phenomenon is enhanced, as expected. It is worth noticing that Nafion[®] is an inert and insoluble polymer, exactly as Teflon[®] from which it is obtained. The solubility of Nafion[®] in water at room temperature - measured by ionic chromatography - is known to be as small as 10^{-6} mol/L. Moreover, in our experiments Nafion[®] was “washed” many times in bi-distilled water previous its insertion into the system. On the other side, it is well known that Nafion[®] has received a considerable amount of attention for “proton exchange” membrane fuel cells, but the physico-chemical basis of these peculiar properties remains a focus of research. In particular, the real physical meaning of the high “proton” concentration in liquid water induced by Nafion[®], widely described in literature, is absolutely not clear.

The analysis of our experimental results in the frame of the coherent Quantum Electro-Dynamic (QED) description of water¹, extensively reported elsewhere [16,17], induces us to consider the following hypothesis: i) liquid water in contact with a highly hydrophilic surface generates aggregates with the size ranging from tens to hundreds of nanometers as it has been observed by light scattering measurements that will be reported in a paper in preparation; this kind of aggregates could be associated to a coalescence of the Coherence Domains (CDs) foreseen by QED theory of liquid water; such an hypothesis is supported by the experimental results in [4-12]; ii) around these extended domains of coherence, an exclusion zone having low pH values exists (i.e. high concentration of H⁺) where the conductivity is higher than in the bulk liquid; iii) the addition of H₂O₂, and its consequent decomposition in OH and OOH radicals, provides the presence of highly reactive species; an alternative hypothesis can be that the H₂O₂ is a source of O₂ molecules which become receptors of the electrons tunneling out of the CDs [2]; iv) the produced radicals may attack any H-containing terminal bonds present in the polymer and deteriorate the system thus causing the fading of the phenomenon after some hours of functioning, or O₂ is developing as a gas outside, leaving the cell.

The filter between the two cells has the function to assure the charge separation among the two volumes of chemically pure water - the CDs aggregates are basically confined in one semi-cell as far as their dimension is higher than the filter porosity.

Should this theoretical hypothesis on the measured Oxhydroelectric Effect in bi-distilled water be true, the commonly shared description of the proton-exchange fuel cells, using a polymer as a membrane electrolyte could be improved of this unexpected phenomenon; the good understanding of the real physical basis of Nafion® behavior in liquid water may lead to a much higher efficiency of the Nafion® based fuel cells.

Conclusions

The Oxhydroelectric Effect exists also in bi-distilled water. This is a totally unexpected phenomenon in the frame of the classical electrochemistry considering the absence of any significant concentration of ionic solutes. The electricity extraction from bi-distilled water by means of two identical Pt electrodes seems to imply some kind of “other than ionic” conduction. As predicted by the QED description of liquid water, the coherent fraction of water, organized in coherence domains and/or their aggregates, provides a wide reservoir of quasi-free electrons [16,17].

The thorough theoretical explanation of the Oxhydroelectric Effect in bi-distilled water and its fundamental governing laws are under exam. The reported results and the physics behind them may imply a real theoretical, experimental and technological breakthrough. Consequently, further interdisciplinary researches are needed to provide definitive knowledge of these phenomena. The advancement in the highly challenging and promising research field on the peculiar dynamic of the liquid water, on the Oxhydroelectric Effect and on its extraordinary wide range of applications is intimately linked to the joint efforts of many experimental and theoretical scientists looking to the pervasive existence in nature of low energy coherent systems (LECS).

¹The quantum electrodynamics (QED) description of liquid water structure shows [6,8] that liquid water is a system in a stable non-equilibrium state due to the co-existence of two phases characterized by different thermodynamic parameters: a matrix of non-coherent water molecules hosting many “Coherence Domains” (CDs), about 0.1 μm in size, in which all water molecules are oscillating in phase with a self-trapped electromagnetic field [16,18]. Basically, at a fixed temperature and for molecules density exceeding a threshold, the transition of the non-coherent water molecules to the coherence state is spontaneous because it is driving the system to a lower energy configuration – low energy coherent systems (LECS). The oscillation of the coherent water molecules takes place between a fundamental state, where electrons are firmly bound (ionization

energy of 12.60 eV), and an excited state characterized by a quasi-free electron configuration. The energy of the excited state is 12.06 eV, which means that only a small amount of energy as $(12.60 - 12.06) \text{ eV} = 0.54 \text{ eV}$ is sufficient to extract an electron. More exactly, the almost free electrons have to cross an energy barrier of $(0.54 - X) \text{ eV}$, where $X \cong 0.1 \text{ eV}$ is the electric potential difference at the CD boundary with the non-coherent water. This small amount of energy, $\sim 0.44 \text{ eV}$, necessary for the electron extraction, makes the coherent water a reservoir of quasi-free electrons that can be easily released by quantum tunnel effect or by small external perturbation (e.g. $\sim 0.44 \text{ eV}$ energy is very well matching the electro-negativity of the O_2 molecule, that, if present in the liquid water becomes the privileged receptor of the electrons extracted from the CDs) [17].

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