Omega Energy Harvester_4.docx

Robert Brian Dopp
DoppStein Enterprises Inc.
1925 Fields Pond Glen
Marietta, GA 30068
Tel: 770 649 1933
RBDopp@doppstein.com

ABSTRACT:

Omega Energy has developed a solid-state energy harvester that contains no liquid electrolyte. It converts water vapor and oxygen into power through a series of reactions on transition metal suboxide intermediates. The solid-state electrolyte (SSE) is made of a lanthanide oxide and a transition metal suboxide in its anode, cathode and separator SSE. It will produce energy as long as oxygen and water vapor are present in its environment.

Field of Invention:

Energy Harvesters are devices that do not store energy, but rather gather it from the environment[1]. Examples include solar power, thermal energy, wind energy, salinity gradients, kinetic energy, and RF capturing devices like the crystal radio among others.

In the past few years, there have been efforts to make a battery using only electrons to transfer charge rather than ions. These devices store energy rather than harvest it. This invention uses various suboxides of transition metals that allow non-integer valence states in the mass of their crystal structures. It uses no liquid electrolyte, but transfers charge using electrons. Being various suboxides, they shift their polarity depending on gaseous oxygen and gaseous water vapor present in the environment. Power is continuous as long as these two reagent components are present.

1 https://en.wikipedia.org/wiki/Energy_harvesting

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General Theory of Operation:

We use several transition metal suboxides that have an average valence less than the stable integer value for that element's oxide: Thus the name "suboxide". This value is, necessarily, the average over the crystal mass. This imbalance also gives each compound an electronegativity that differs for each compound. The active cathode material is less electronegative than the anode material, and thus is "electropositive" relative to the anode. Our Solid State Electrolyte (SSE) transfers the charge using another transition metal suboxide and a lanthanide oxide. The anode and cathode both also contain carbon, so the SSE, having higher impedance, separates the charge.

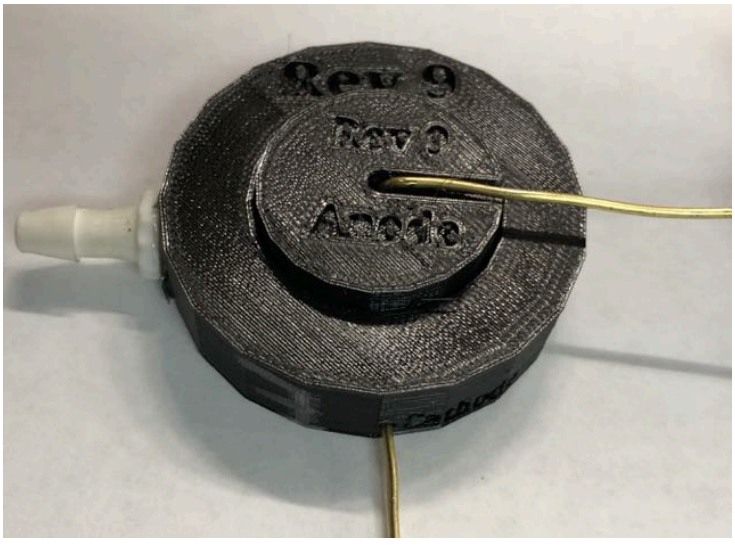
Oxygen and water vapor enters the cathode, carrying its two negative charges (electrons) and using the water's hydroxyls. The oxygen nestles into the crystal structure and defects of the cathodic reagent, making an excess of electrons, which slide onto the SSE crystals with their loosely bound oxygen atoms with the help of hydroxyls, carrying two electrons with them. These are free to migrate throughout the cell, being attracted by the lower electronegativity of the anode suboxide and facilitated by the SSE also included in the anode and cathode formulation. The anode suboxide collects an excess of electrons, which can then be released to an external circuit giving a power output.

The anode and cathode uses carbon black (or graphite) to reduce the impedance of those active electrodes, while retaining the higher impedance in the SSE situated between the electrodes as a solid-state separator of charge.

Electrode and Cell Making:

The project started with pellets made in a piston-cylinder type compression apparatus but has evolved into making cells using a rolled process making thin sheet anodes, solid-state separator and cathodes all bound with unsintered PTFE powder. A typical cell's active stack is ¾" (19 mm) in diameter and .15" (3 mm) thick. Our cell is built inside a polyethylene (PETG) 3D printed case, which allows for controlled airflow and compact design. The 2-inch diameter is to fit conveniently in the test apparatus, where they can easily be stacked in series. Holders have also been printed to hold many cells in parallel with one case.

Present Cell Image:



Performance:

The cell shown is our run number 20419.4

Figure 1 shows the polarization curve expressed as a voltammogram.

Figure 2 shows the power curve, which is the first derivative of the polarization curve, being the product of the two axes versus potential. The maximum power point (MPP) is usually reached at about 60% of the exchange potential.

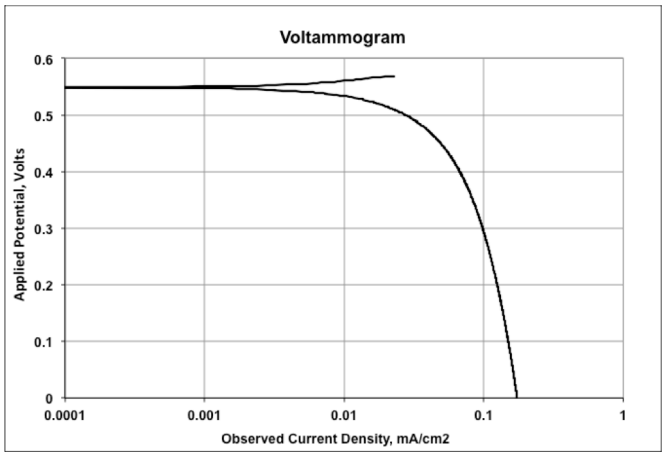


Figure 1

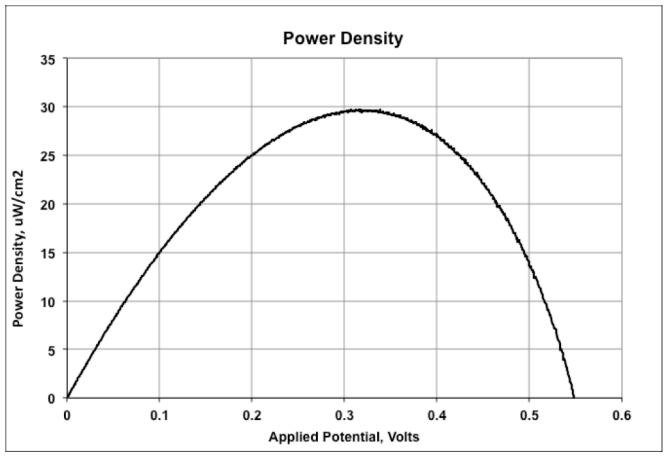


Figure 2

Figure 3 shows the impedance Bode plot. The Ohmic impedance is roughly 1300 Ohms.

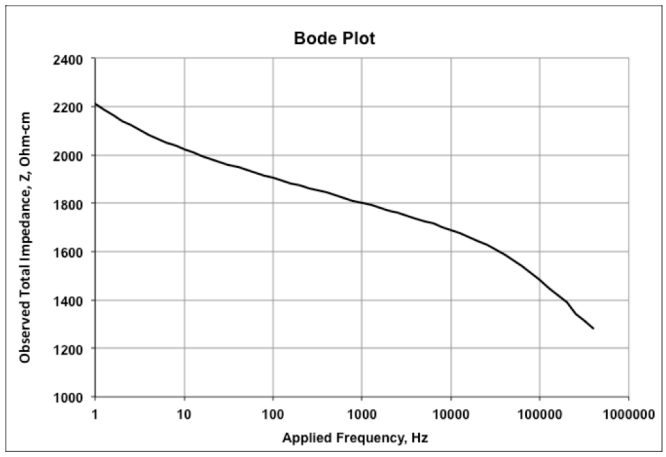


Figure 3

Summary:

- The Omega Energy Harvester is capable of producing power from air and water vapor.
- The energy level is roughly 30 uW/cm^2 at about 0.3 volts per cell.
- Could run a low power transmitter or receiver.
- Series-parallel arrangements can deliver higher voltage and more power.