Second Law Violating Nanochip (SLVN)

Horace Heffner September 1996

GENERAL

The purpose here is to discuss issues regarding the construction of a Second Law Violating Nanochip (SLVN). The goal is to design a device that demonstrates that the assumed Second Law of Thermodynamics is invalid by showing that it is possible to extract heat from one of two equal temperature compartments to increase the temperature of the second compartment. That is to say, extract kinetic energy from matter in the first compartment, convert it to electrical energy, and heat the second compartment via a joule heater. Second law violation has historically been a subject of extensive investigation. [1][2][3]

THE PIEZO-KINETIC APPROACH

Let us consider the possibility of manufacturing a chip with very thin very small piezoelectric crystals on the surface connected to integrated full wave diode bridges. The output of all the tiny bridges would be collected together, the chip placed into a heavy noble gas. Suppose the chip is placed in a compartment adjacent to which is another compartment at the same temperature. The chip drives a joule heater in the second compartment. At some operating temperature it might be possible to convert kinetic energy from one compartment to electrical energy, which is then transferred to the kinetic energy of the second compartment. The difficulty is making the chip so it will not be destroyed by the operating temperature and the piezoelectric crystals small enough in area compared to the size of the impinging gas molecule, so that the voltage generated by the piezo-compression is sufficient to make it through the diode bridge, i.e. to overcome the diode forward bias potential. The peizo must have a small surface area to prevent the charge being spread over a wide plate, thus reducing the voltage. Any required energy requirement can be met by utilizing a sufficient particle energy, or operating temperature. The main difficulties are achieving a small piezo area, a small integrated full wave bridge in the same cross section, and low enough diode forward bias.

For a rough first cut at this assume an operating temp of 300 K.

Since 1 eV = 11,600 K, at 300 K the typical particle in a gas will have an energy of 300/11,600 eV = .026 eV = .026 * (1.602 x 10^-19 J/eV) = 4.166 x 10^-21 J.

Let's assume we want to charge a capacitor to .3 V. Since E = .5(C)V^2 we get C = 2E/V^2 = 2*(4.166 x 10^-21 J)/.09 F = 9.76 x 10^-20 F.

Now C = Ke (A/w) (8.85 x 10^-12 F) where Ke is the dielectric constant, A is the plate area in m, and w is the thickness of the capacitor in m. For the sake of simplicity and to get scale, let's assume A = w^2, and Ke = 4, so C = 3.54 x 10^-11 F/m * w. So now w = (9.76 x 10^-20 F)/(3.54 x 10^-11 F/m) = 2.76 x 10^-9 m. The structure size for the device should be in the range of about 27.6 Angstroms. The atomic radii of Si, O, and Au are 1.46 A, .65 A, and 1.79 A respectively. So 27 A represents a structure about 7-10 atoms across.

However, this assumes a perfectly non-elastic collision every time (estimate optimistic), yet the kinetic energy of a gas is a distribution, so many collisions will be more energetic, some much more so (estimate pessimistic).

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So, what does this say? The design is unfeasible. The structures are too small to be practical or functional. The difficulty centers about the need to focus on a small enough area a sufficient amount of energy to overcome the forward bias of the diode. The forward bias sets a minimum voltage level, which sets a maximum surface area over which the generated charge is to be distributed. If the forward bias of the diode were zero then there would be no upper limit to the size of the energy trapping structure, but like with Brownian motion, smaller gives more of a result.

What about power? If such a device can be built that works at all, then there is a very good potential for significant energy production. This is because, assuming some of the generated energy is returned to stir the gas, a very large percentage of the molecules will connect with the sides of the container per second. This means a significant portion of the specific heat of the gas could be drained off per second. One problem with the chip might be maintaining balance, not cooling the compartment so much the energy is not transferred and yet not overheating the chip. But those are much easier problems.

THE CHARGE-TRANSPORT APPROACH

Having seen some of the difficulties of extracting energy from neutral gas particles, it is now easier to appreciate the advantages of extracting energy from an electrolyte. Here, the idea is to use local charge fluctuations, thus indirectly heat, in an electrolyte to drive the chip. Similar particle kinetic energies apply, based on temperature, however, the energy of individual particles (or clusters of particles, or even large brownian type particles) is expended driving a charged particle to an electrode, as opposed to driving a neutral particle to a crystal to generate a piezo electric effect. One advantage of this approach is that the operation directly results in electrical energy. Other advantages are increased efficiency due to less generation of heat from the resulting collisions, and a reduction in the number of parts to each element on the nano-chip (only a diode and protective covering is required.)

The method is to build the chip out of vertical diodes separated, i.e. surrounded by, a lattice of insulating material. Two type of chips could be built, positive exposed end (PEE) and negative exposed end (NEE) diodes, as opposed to NP or PN. The diodes would have one end attached to a shared conducting plane, the other end exposed to the electrolyte. Except for the conducting plane shared in common, the diodes would be electrically isolated from each other except through the electrolyte. The face of each diode would be hardened with a layer of gold.

A PEE chip could be manufactured, for example, by building, on top of a substrate, an N doped layer, then a P doped layer, followed by a Gold layer. This could be followed by cutting a lattice of grooves, leaving a matrix of small independent diodes, and then filling the groves with an electrolyte impervious insulating material and then removing the top layer of insulating material sufficiently to expose the gold contact points but not the diode material.

The resulting PEE SLVN would look like that shown in Fig. 1.

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EEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEE
HHHHHHHH GGGGGGGG HHHHHHHH GGGGGGGG HHHHHHHH GGGGGGGG HHHHHHHH
HHHHHHHH GGGGGGGG HHHHHHHH GGGGGGGG HHHHHHHH GGGGGGGG HHHHHHHH
HHHHHHHH PPPPPPPP HHHHHHHH PPPPPPPP HHHHHHHH PPPPPPPP HHHHHHHH
HHHHHHHH PPPPPPPP HHHHHHHH PPPPPPPP HHHHHHHH PPPPPPPP HHHHHHHH
HHHHHHHH NNNNNNNN HHHHHHHH NNNNNNNN HHHHHHHH NNNNNNNN HHHHHHHH
HHHHHHHH NNNNNNNN HHHHHHHH NNNNNNNN HHHHHHHH NNNNNNNN HHHHHHHH
HHHHHHHH SSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSS HHHHHHHH
HHHHHHHH SSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSSS HHHHHHHH
HHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHHH
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E - electrolyte,
G - gold or other protective conductor,
H - insulating material impervious to electrolyte,
N - N type semiconductor
P - P type semiconductor
S - substrate

Fig. 1

A PEE type array and a NEE type array would be placed in an electrolyte simultaneously. As the random motion of the liquid would bring charges close, and then move them away, the induced field in the diodes would cause current to flow, but primarily in accord with the diode polarity. Moving the charges away from the exposed diode ends would reduce the kinetic energy of the electrolyte. A charge would be build up on the exposed end of the diode which would eventually attract an ion that would be neutralized. Electrolysis would result. This brings the diode back to a neutral position to recycle. Three good things happen: the electrolyte cools, current is available, and electrolysis occurs.

It seems reasonable that this is a workable idea, based upon the problems and limits of chip miniaturization. One limit is power density, but another is the fact that molecules bouncing off chips produce electric pulses. The fact that the electric pulses can be significant at some level of miniaturization means that impacting molecules are able to generate voltages in excess of the minimum to required to exceed the diode or transistor bias.

However, to make the design more practical and immediately implementable, a method is now suggested to overcome the diode bias potential, the PN forward barrier potential, and thus increase the maximum size of the nano-structures required to extract the kinetic energy of the electrolyte. The method suggested is to capacitively bias the interface, to establish a field gradient that increases the ion concentration and charge in the vicinity of the chip surface.

Fig. 2 shows a suggested arrangement:

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IIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIII
EEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEEE
PPPPPPPPPPPPPP EEEEEEEEEEEEEEEEE NNNNNNNNNNNNNNNNN
IIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIIII

+ - a positive conductive plate
- - a negative conductive plate
I - insulating wall of electrolyte container
E - electrolyte
N - NEE chip
P - PEE chip
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Fig. 2

The PEE and NEE chips would be electrically connected via a power extraction device. Such a power extraction device might include a pump of some kind to move the electrolytic fluid. Such movement, in addition to assisting in degassification, would actually increase the electrolysis. It should be noted that such electrolysis resulting strictly from electrolyte flow, i.e. energy extraction from the the fluid flow, is exactly offset by pump power requirements. The movement of charge against a field gradient increases the fluid flow resistance.

The main advantage of this approach is to bias the input potential to the diode array by jamming a large number of ions of the correct potential toward the surface of the diode array, thus minimizing the size of fluctuations in potential required to cause current flow across the diode forward potential barrier. Note that no energy is extracted from the charged metal plates which create this bias potential, as they are insulated from the electrolyte. The + plate drives + ions toward the P type semiconductor, which positively biases the the P side of the PN junction. This bias allows the small ionic noise voltage oscillations to generate current across the junction. If a plus charge is lost to the diode current, this creates a plus deficit or net negative charge on the surface of the PEE chip. This charge deficit is made up through electrolyte diffusion, thus heat is extracted from the diffusion process itself. If the fluid is flowing then this process is further enhanced.

Due to the statistical effects of the motion, electrical noise level and the oscillating potentials in an electrolyte, especially a flowing electrolyte, can get fairly high compared to the potential a single charged particle can cause. A kind of macro level thing happens, similar to brownian motion. It could possibly be enhanced with colloids.

Of course pumping, H_2 extraction, etc., are simply practical matters. The electrical power generated could also be used to heat the theoretically all important second compartment. The important issue here is hope. If the Second Law is dead, there is then solid hope for "the" energy solution. A successful yet very small scale demonstration would be of very great scientific and practical value.

The present chip technology keeps getting smaller and smaller, and the diodes and transistors in them work very reliably. Someday nanotechnology will catch up to thermodynamics and change the rules. The question is, are we close enough today? It appears we are.

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Maybe the macro side of things is the place to start. This should not be minimized even though the diode I/V curve is very flat until the barrier potential is reached, *some current* must be provided to maintain the bias, and that current increases as the barrier potential is approached. Capacitive bias will not do the whole job. That's where fluid motion comes in. There is a way to prime the pump, so to speak. The idea is to have two tall columns of electrolyte (probably in a well casing in a practical application). Set up a very high voltage bias (e.g. 20,000V) on the capacitor plates. Use a pump to start the electrolyte around a loop that includes the two columns - one up - one down. Put the bias electrodes around the up column. Inside the up column is simply a wire, or even a wire connecting the two SLVN chips. Immediately, due to the electrolyte pumping, electrolysis should start. You don't even need chips to do that, just a conductor in the electrolyte opposite to and between the two outside capacitor plates. Now, the gas bubbles will start to rise. As the bubbles rise they will expand as well. The up column will be lighter than the down column. The process will also provide the small bias current needed by the plates to generate electrical energy. The process could become self-sustaining without the pump due to the bubble lift providing the fluid motion. Not a large electrolyte flow is necessary to gain some current flow to maintain the bias, or even to produce the electrolysis products. The place to start may be in quantifying some of this, empirically.

It is interesting that John Logajan had some posts [in sci.physics.fusion] at one time about the seeming imperviousness of electrolysis energy requirements to pressure. He conducted an experiment where hundreds of pounds of pressure were generated by electrolysis at the points of a spark plug mounted in a sealed steal cylinder. The electrolysis products are proportional to current, the current is proportional to the overvoltage. The question then is - at a fixed voltage of electrolysis, is the overvoltage reduced by increasing pressure? If not [as Logajohn's experiment indicated] - there is an opportunity for free energy right there. Instead of a 300 foot well, go for a 2000 ft. well, or maybe the ocean, and really get some energy out of the electrolysis bubble lift!

Fig. 3 shows a single electrode gas separating bubble lift electrolysis device design:

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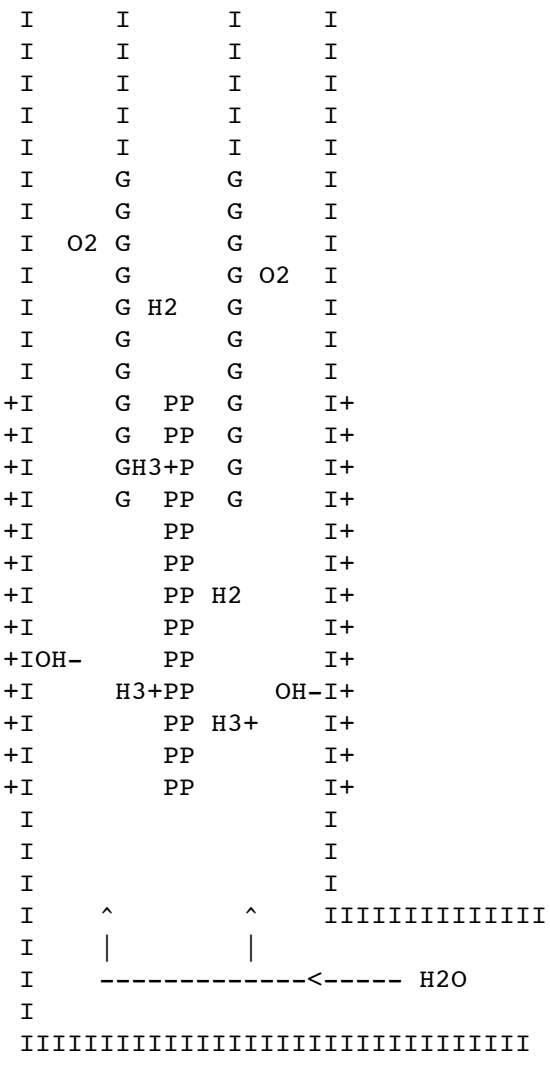

+ - capacitor (no current) anode plates
I - insulating tubing (or plates)
G - grounded metal tube (or plates)
P - PEE type SLVN connected to load and then ground
(or even simply a grounded metal electrode, just to get electrolysis)

Fig. 3

Note that there is no electrolysis current provided, only fluid flow. The grounded metal tube (or plates) has a lateral electric current through it generated by OH- and H3+ charges driven to it my mutual attraction once they are no longer in the capacitor field gradient. It would be possible to make the grounded metal G into two tubes (or plates) separated by an insulator - and then extract

and utilize the electrical current between them. Note also that the bubbles generated assist the fluid flow. The up column above this device is lighter than the return column for the H2O.

The operating outer plate voltage could operate at a potential of 20 KV or more, depending on insulation and plate separation, but would have to be reached gradually to prevent destroying the diode array.

[1] Yater, Power conversion of energy fluctuations," Phys. Rev. A 10, 1361 (1974); Comments by EerNisse, Phys Rev A 18, 767 (1978); Rebuttal by Yater, Phys Rev A 20, 623 (1979).

[2] Articles by Maddox in Nature with titles "Directed motion from random noise," and "Bringing more order out of noisiness," both in vol 369, pp. 181 and 271 (1994).

[3] J. Travis, "Making light work of Brownian motion," Science 267, 1593 (1995).