A Technique for Making Nuclear Fusion in Solids – More Elements

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Abstract: A technique is demonstrated for making nuclear fusion at room temperature by passing an electric current through a new-found mixture of hydride and catalyst powders. The result is explosive beyond chemical reaction for the materials.

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1 Introduction

Nuclear fusion as an energy source needs to be developed in order to reduce global-warming, see original article [1]. Many scientists have been conducting Low Energy Nuclear Reaction experiments over decades [2]. Thermonuclear fusion projects have been steadily advancing for 75 years. Recently, inertial fusion using a projectile to impact DT nuclear fuel has shown promise as an economical method [3].

In this article, it will be demonstrated how to generate nuclear fusion at room temperature by passing an electric current through a new-found mixture of hydride and catalyst powders, [JR, private communication]. Or, as shown previously, fusion may be generated by mechanically shearing the mixture under compression. Repeatability is assured for these techniques.

Section 2 describes current experimental methods. Section 3 offers an explanation for the chemical processes involved. Section 4 proposes ways to develop a commercial energy generator. Section 5 summarises the work.

2 Experimental methods

The procedures developed here have been done on a small scale but they generate explosions which cannot be explained away as normal exothermal chemical reactions. A number of experiments have been performed to discover a reproducible effect applicable to energy generation. The explosions were created inside a transparent box for safe observation and to catch debris for analysis.

2.1 Fuel preparation.

The primary fusion fuel was made by mixing 1g of 95% lithium aluminium hydride $LiAlH_4$ powder with 1g of 98% boron carbide B_4C powder and 1g of 99% metallic zinc Zn powder. Typical particle sizes of the powders have been in the range 20 to 75 μm, while the weight proportions of the ingredients have been varied around 1:1:1. These values do not appear to be critical and different hydrides or deuterides, and metal powders may be worth investigating, depending on the project.

2.2 Shear-induced fusion experiments.

In these experiments, about 80mg of the primary fuel powder is put in a compression cell consisting of two hardened chrome steel roller bearings (6mm x 20mm) aligned as the anvils in an acrylic block, see Figure 1. When this primed cell is subjected to compression up to 5 tons or more in a hydraulic press, it may explode violently. The explosion is distinguishable from a simple bursting process because the resultant anvils show radial wear with pitting and fracture, while the acrylic fragments show wedge formation, fractures and local melting. In the light of experiments described in the original article, it is deduced that shear must occur within the fuel pellet during compression such that hot-spots in the shear-plane cause chemical exothermic reactions. These liberate ionised hydrogen from the hydride which interacts with adjacent catalyst particles and leads to proton-proton confinement fusion when the electron density is high enough for screening. The process ceases as soon as the cell is cracked for the pressurised gases to escape.

In order to generate power, the fuel could be packed into the tip of a projectile to be propelled into a funnel-cavity; or vice versa. Any of the current compression techniques using projectiles, laser beams, particle beams or z-pinch effect may be applied.

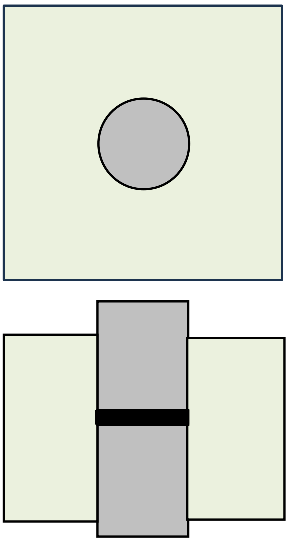


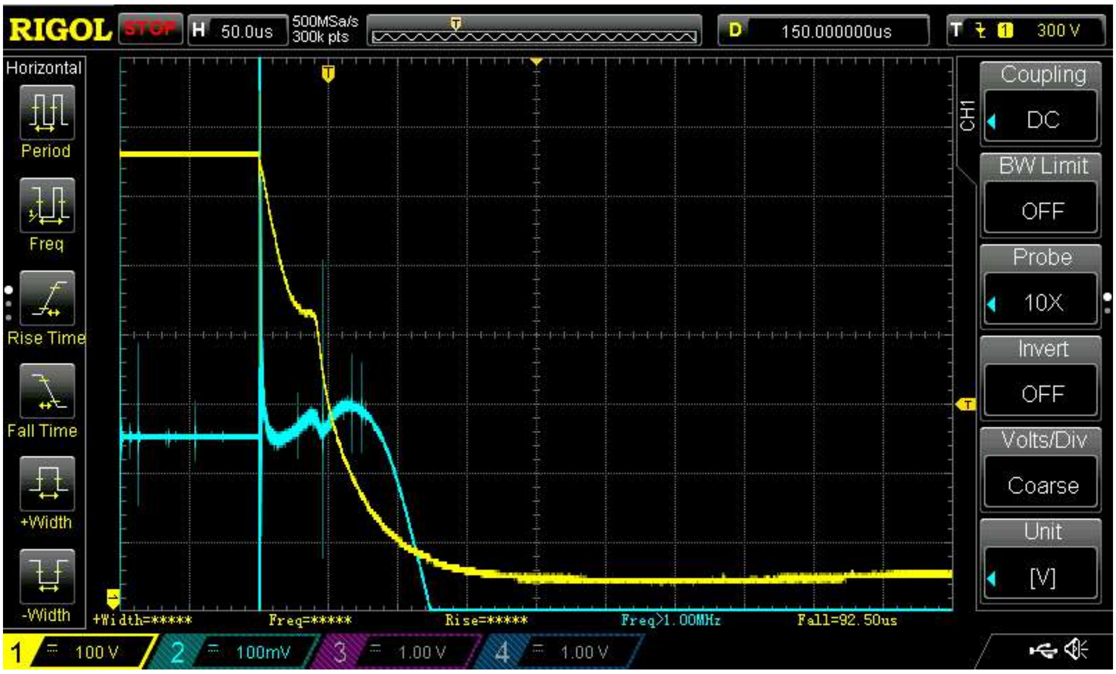
Fig.1. Compression cell design showing fuel between steel anvils aligned in an acrylic block, of size 32mm x 32mm x 24mm.

2.3 Electrically induced fusion experiments.

In order to control the explosion strength and timing, experiments were done employing hot-wire-ignition, instead of shear-ignition. For this, the compression cells were the same as in Figure 1 but constructed to have a stainless-steel filament (0.5mm x 0.05mm cross-section x 8mm long) imbedded diagonally through the compressed fuel pellet. To ignite the fuel, a brief high current discharge greater than 10,000amp was passed through the filament, from a 1350μF electrolytic capacitor (C) charged to 650volts (V). The cell would then explode, producing debris similar to the shear experiments. By reducing the size of the capacitor and the voltage, the explosion could be moderated.

While doing these experiments, it was found that the primary fuel mixture under pressure is semi-conductive such that the measured cell resistance may decrease to less than a kilohm as it is compressed. Consequently, a hot-wire is not necessary and direct connection of the charged capacitor to the compressed primed anvils will ignite the explosion. The experimental results show some variability in explosion strength but they may be classified according to the compression loading and cell strength as determined by its dimensions. The actual path of the conduction through the fuel between the anvils may vary, being near the wall or centre, and affect the plasma growth. For these experiments, the compression load has been monitored continuously by means of a Tekscan Force Sensor A502 with a response time of 5microsec, placed under the cell. Its particular mechanical construction and control circuitry had to be calibrated using known applied loads; thereafter it was reliable and robust.

During the ignition, the voltage (V) on the capacitor (C) has been monitored on an oscilloscope and found to be informative, as shown in Figure 2 for a typical low-compression example. The discharge current at the beginning of the ignition is seen to be very high, ($I = -C\, dV/dt$) greater than 10,000amp, indicating that the ionised fuel in the cell is a highly conductive plasma. And the discharge is not a simple exponential decay, as it would be for a fixed resistance (R) with time constant ($\tau = RC$). Instead, the explosion impedes the high discharge rate.



H 50.0us 500MSa/s 300k pts

D 150.000000us

T 1 300 V

Coupling DC

BW Limit OFF

Probe 10X

Invert OFF

Volts/Div Coarse

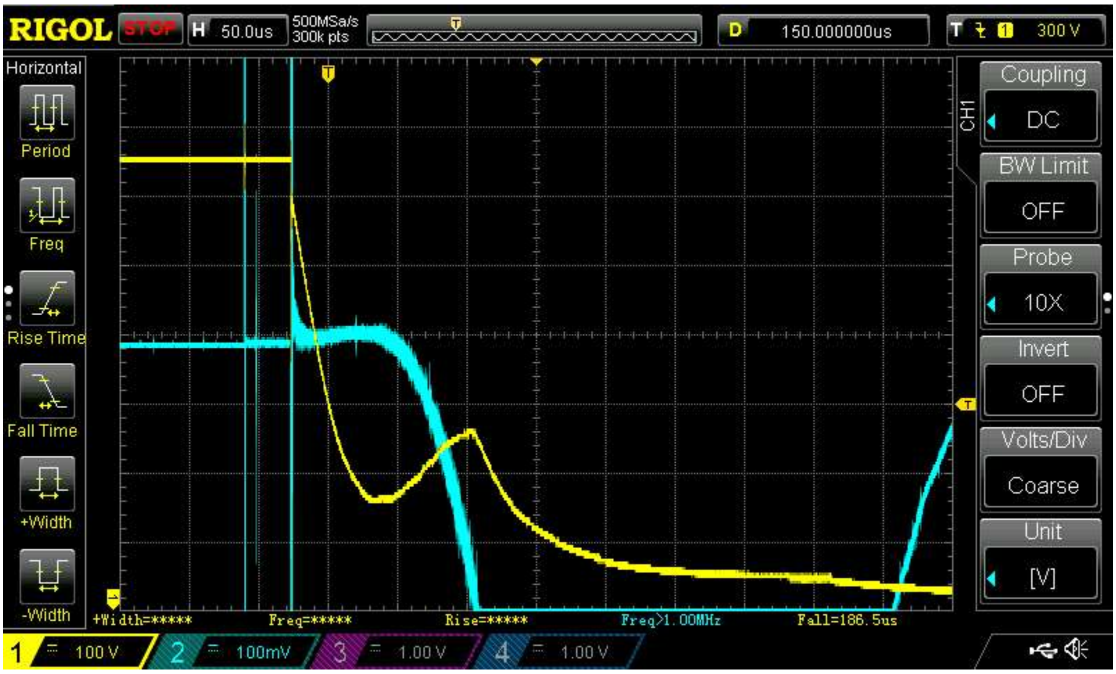
Unit [V]

+Width=***** Freq=***** Rise=***** Freq>1.00MHz Fall=92.50us

1 100 V 2 100mV 3 1.00 V 4 1.00 V

Fig. 2. Experiment138 Yellow trace:- The measured voltage on the capacitor shows that the initial high discharge *rate* is slowed to zero by the explosion, then increases to a greater rate for a short time before falling to near zero. Turquoise trace:- Compression load, (for low-compression 0.32tonne), measured during the ignition shows an interference pickup glitch for 10μs due to the capacitor contact-arcing, followed by a stepped increase due to the explosion. Next, the deep fall confirms that the fuel plasma was blown out of the cell as it shattered into several pieces. Loading was re-established later (not shown) at a lower level when the anvils closed together with no fuel or acrylic cell.

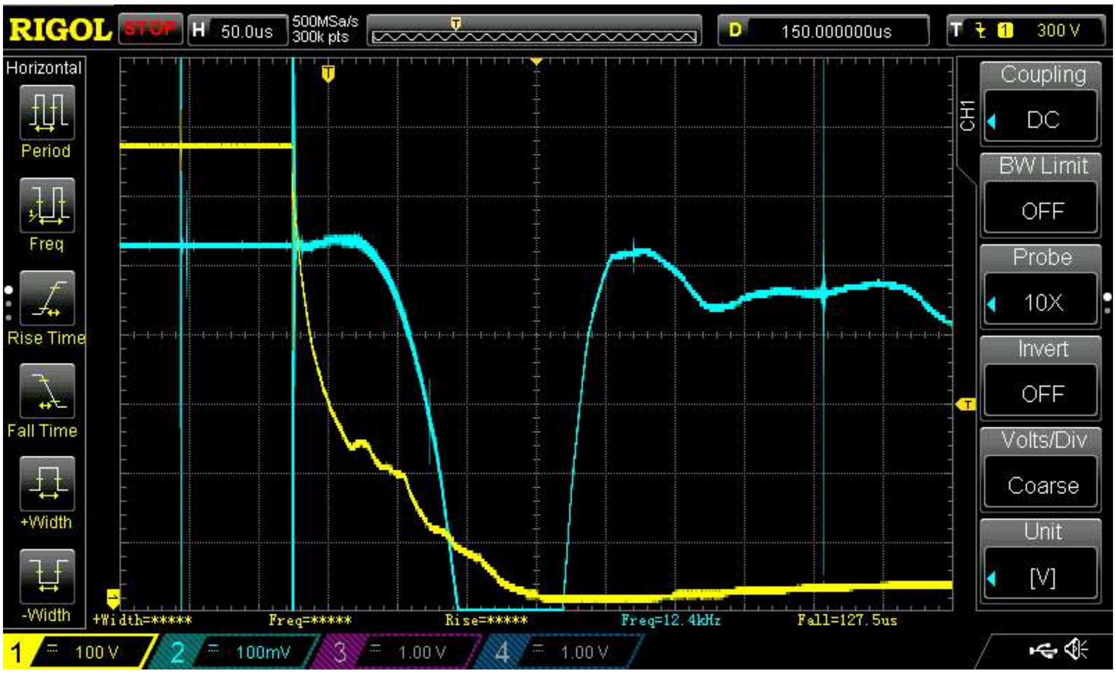
Figure 3 shows how a medium strength explosion appears to counteract the capacitor discharge current as if charge in the plasma is driven into the capacitor to increase its voltage, at the same time as the plasma is being blown out of the cell.



H 50.0us
500MSa/s 300k pts
D 150.000000us
T 300 V
Coupling DC
BW Limit OFF
Probe 10X
Invert OFF
Volts/Div Coarse
Unit [V]
+Width=***** Freq=***** Rise=***** Freq>1.00MHz Fall=186.5us
1 100 V
2 100mV
3 1.00 V
4 1.00 V

Fig. 3. Experiment132 Yellow trace:- For medium-compression ignition, the voltage monitored on the capacitor shows that after 50µs the discharge is counteracted by a significant flow of charge from the plasma forced back into the capacitor over a period of 100µs. Turquoise trace:- Compression load measured during the ignition starts at 0.8tonne then shows a glitch of interference then a small increase due to the explosion. The following deep fall lasts while the fuel plasma is being blown out of the shattering cell over 300µs, then some loading is re-established as the anvils move into contact and remain in place with no fuel or acrylic cell.

However, Figures 4 and 5 show that higher compression explosions do not achieve this reversal of current because most of the plasma is blown out of the shattering cell too quickly for the correct plasma conditions to develop. So, higher compression produces stronger and faster explosions which would grow and yield more fusion energy if they could be confined for longer as in an inertial confinement process.



H 50.0us
500MSa/s
300k pts
D 150.000000us
T 1 300 V

Coupling DC
BW Limit OFF
Probe 10X
Invert OFF
Volts/Div Coarse
Unit [V]

+Width=*****
Freq=*****
Rise=*****
Freq=12.4kHz
Fall=127.5us

1 100 V
2 100mV
3 1.00 V
4 1.00 V

Fig. 4. Experiment144 Yellow trace:- For higher-compression ignition, the voltage on the capacitor shows how the rate of discharge is decreased by the explosion plasma as it falls towards zero. Turquoise trace:- Compression load measured during the ignition starts at 1.6tonne then shows a glitch then an increase due to the explosion. The following deep fall lasts for 100µs while the fuel plasma is being blown out of the shattering cell, then loading is re-established as the anvils move into direct contact and remain with no fuel or acrylic cell.

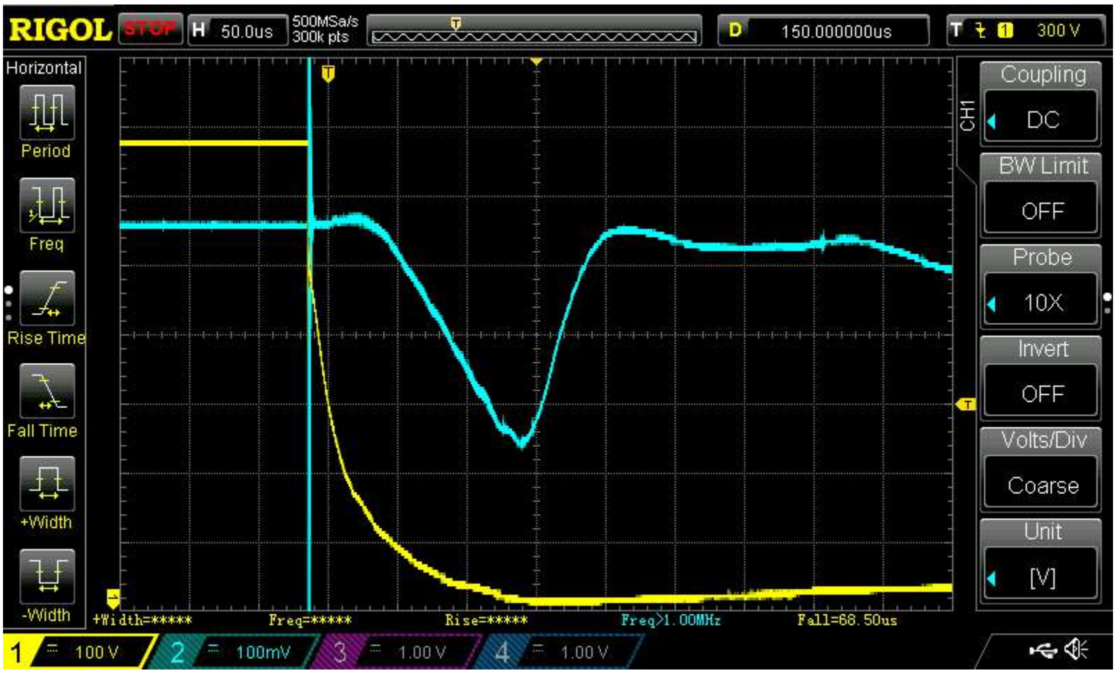


Fig. 5. Experiment145 Yellow trace:- For higher-compression ignition the voltage on the capacitor shows the rate of discharge is only slightly affected by the explosion plasma. Turquoise trace:- Compression load measured during the ignition starts at 2.4tonne then shows a glitch then an increase due to the explosion. The deep fall lasts for 130μs while the fuel plasma is being blown out of the shattering cell, then loading is re-established as the anvils move into contact and remain with no fuel or acrylic cell.

Experiments were also done wherein calcium deuteride powder was added to the primary fuel mixture in similar proportion to the lithium aluminium hydride. A low-compression example of the ignition is shown in Figure 6. Higher-compression results were similar to Figures 4 and 5.

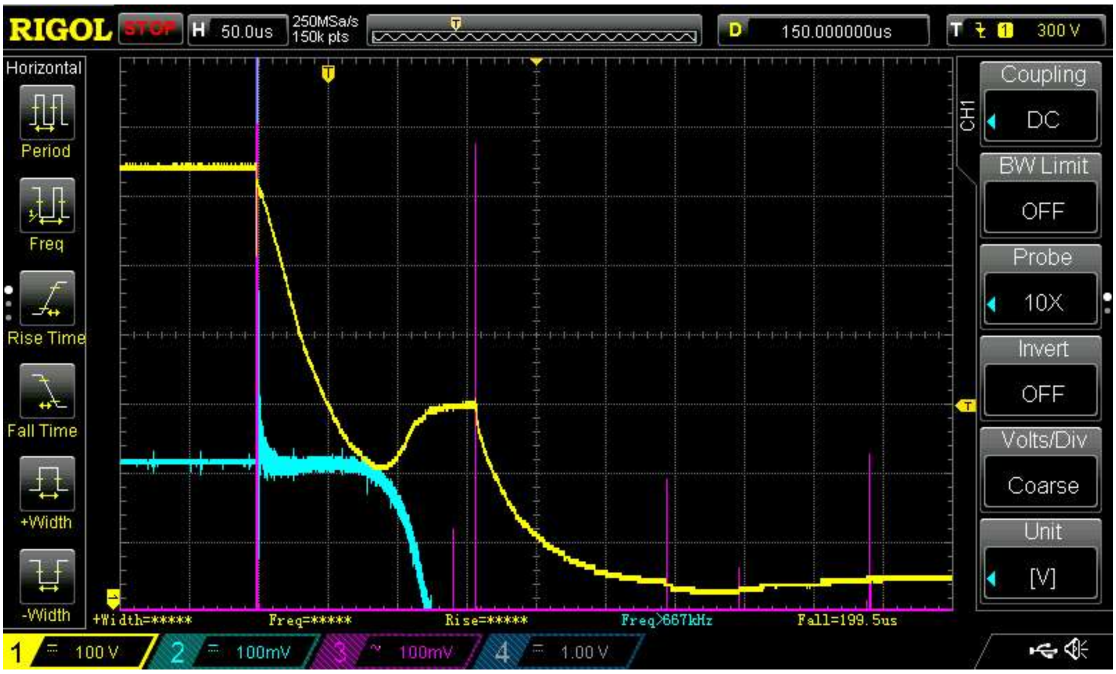


Fig. 6. Experiment191 Yellow trace:- For low-compression ignition, the voltage on the capacitor shows how after 85μs the discharge current is counteracted by a significant flow of charge from the plasma into the capacitor over a period of 70μs, before falling towards zero. Turquoise trace:- Compression load measured during the ignition starts at 0.4tonne then shows a glitch of interference then a small increase due to the explosion. The following deep fall lasted while the fuel plasma was being blown out of the shattering cell, then loading was re-established (not shown) as the anvils moved into contact and remained in place with no fuel or acrylic cell. Red trace:- The BP4 detector output only shows unimportant glitches induced by steps in capacitor discharge current through the disintegrating cell.

2.4 Search for nuclear debris.

Some effort has been put into the search for any nuclear particles emitted by the explosions, but none has been found for sure. Detector type NE Rate Meter RM5+beta probe BP4 with steel mesh screening was located at 10cm from the fusion cell and subjected to the blast many times. Half the face was covered with indium foil to detect any neutrons but none was detected.

3 Proposed chemical processes

Catalytic properties have been attributed to boron carbide [4] and metallic zinc [5]. It is proposed that chemical ionisation enables nuclear processes to occur within the fuel when subjected to rapid localised heating under pressure. First, hydrogen ions are freed from the lithium aluminium hydride and occupy spaces between rough surfaces of boron carbide and zinc grains. Here they are dynamically constrained while being bombarded by energetic protons and electrons in the hot plasma. In this environment, the repelling Coulomb force is screened by a dense field of electrons so that fusion can occur between free and constrained protons via a p-p reaction. The energy released leads to avalanche fusion if the confinement can be maintained long enough.

In a few experiments, adding calcium deuteride to the primary fuel mixture appeared advantageous, as if deuterons could have increased nuclear p-d and d-d reactions. However, when calcium deuteride replaced lithium aluminium hydride, the explosions were weaker than normal, which could imply that lithium ions assist the fusion process. Experiments using lithium boron hydride in place of lithium aluminium hydride might be advantageous in future.

4 Further developments

The experiments described above prove that nuclear fusion is possible in specific solid-state materials. Commercial energy generation could involve a pellet of this fusion fuel being compressed by a projectile or by lasers, particle beams, or a Z-pinch cell. When optimising these different techniques, the fuel ingredients might also be varied in their proportions and by substituting other chemicals in part.

5 Conclusion

Investigations into low energy nuclear reactions have been conducted on specific mixtures of hydride/deuteride and catalyst powders. When these mixtures were compressed and ionised in a cell, strong explosions occurred where the Coulombic screening was sufficient to enable p-p or p-d or d-d nuclear reactions. These results were fully reproducible at will, and now require commercial development using ICF techniques for energy production. A detailed nuclear theory is not necessary before substituting this fuel in place of the standard DT fuel currently being used in existing ICF machines. By prioritising this auspicious discovery, we will be able to counter the increasing climate change [6] which is visible to all, destroying the earth at great cost. Today, scientists and engineers with the right attitude have the tools to do the job required.

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