

HIGH TEMPERATURE CORE CREATION IN THE P-N JUNCTION OF SEMICONDUCTOR DEVICES AND ITS USAGE FOR FUSION

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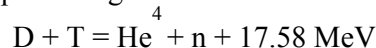
Abstract: *The growing number of nuclear power plants confronts scientists with the problem to increase significantly the proportion of the public security. This requirement gradually makes the projects expensive and unacceptable for energy production. This problem motivates the researchers to generate a variety of ideas, some of them rather exotic at first glance. The utilization of thermonuclear synthesis is part of the efforts to obtain cheap, safe and clean energy. Unfortunately, the fundamental projects for building fusion reactors encounter significant difficulties at this stage. A number of scientists attempt to improve the existing know-how. Others try to realize fundamentally new ideas to control the fusion. The goal of such proposal is in the realization of many consecutive micro-thermonuclear explosions, so that the energy to be absorbed in small portions without destroying the power plant.*

Key word: *inertial confinement fusion; micro fusion bomb; semiconductor electric lighter*

1. INTRODUCTION

The growing number of nuclear power plants and their hazardous processes provoke scientists to improve the requirements for preventing incidents. This challenge makes the nuclear energy industry progressively more expensive and not so attractive for energy production. For this reason both scientists and governments are focused on the building and utilization of fusion power plants, which function upon synthesis of light nuclei. The main advantage of these plants is that they are environmentally clean, safe and would provide much more energy per mass of fuel than any current technology. Over the years a major area of study has been directed toward construction of modern fusion reactors as it is pointed out in the international project ITER [1].

The most promising nuclear fusion reaction is:



This is due to the fact that it is energetically most efficient.

The effectiveness of fusion can be explained by the following examples: one gram of D-T plasma can produce 100,000 kWhs electricity, which are equivalent to the energy produced by 8 tons of coal; or by "burning" a glass of deuterium enriched water; or by burning one ton of oil. Deuterium is a naturally occurring isotope of hydrogen in a ratio 1: 7000 in water and can easily be separated from it [1].

2. CERTAIN KEY PROBLEMS IN NUCLEAR REACTOR.

In order to achieve fusion, the plasma and the reactor should meet certain criteria, first defined by Lawson[1].

1. Sufficiently high temperature of about $T = 4.10^9$ K. At that temperature, required for a fusion, the deuterium is in the form of plasma with very good electrical conductivity [2].
2. The plasma should be dense enough in order to achieve many nuclear fusions reactions.
3. Strong magnetic field for plasma confinement.

4. The time of plasma confinement ($n\tau$) should be greater than $10^{20} \text{ m}^{-3}\text{s}$ (a result from the multiplication of plasma density and its retaining time in the reactor) [3].

The practical realization of these requirements is unachievable with available technologies.

3. NEW PHILOSOPHY OF CONTROLLED NUCLEAR FUSION

The development of laser-based concept for fusion is not only innovative, but also a new way of thinking [4], [5]. Until recently, the idea of energy production as a result of thermonuclear explosion has been categorically rejected because of the destructive nature of the process. Today, due to breakthroughs in laser technology it is suggested that a hydrogen bomb could be made so small, that its blasting will have no destructive effect [6]. So, a detonation of a series of small bombs practically would lead to a controlled fusion reaction [7], [3].

The most sophisticated experiment in this field was held in 2011 in the laboratory of the U.S. scientific complex - National Ignition Facility (NIF). There a system for ignition of a capsule filled with a hydrogen fuel was successfully tested [8], [9].

In order to start a fusion reaction, a D-T nuclear fuel in the form of an ice-ball (target) with density of 10^{29} particles per m^3 and diameter of 1 mm is needed. The very small fuel quantities are obligatory in order not to destroy the reactor. Further, 192 laser beams are focused not on the fuel capsule itself, (containing a beryllium shell and fusion fuel, typically a mix of deuterium and tritium) but on the metal cylinder in which it is contained. The latter is heated and the produced energy is irradiated as X-rays that interacts with the fuel. The energy should provoke a rapid evaporation and leakage of the material (ablation) from the capsule surface due to the beryllium [10]. The ablation will also create a shock wave that travels toward the center of the fuel, where a smaller volume is further heated and compressed to achieve fusion parameters. Fusion reactions will occur and the released energy will flow towards the outside. Instead of magnetic fields, the plasma is confined by the inertia of its own mass – thus the term inertial confinement fusion (ICF) [11], [12], [13]. This procedure with 192 laser beams however, is rather complicated and the produced energy should be rather expensive. In the paper we propose a new idea for a simpler procedure:

Construction of Cheap Electric Disposable Lighte

In our system, the micro fusion bomb (ice microsphere), the electric lighter and the electronic switcher are situated on a chassis, conditionally called nuclear fusion reactor. It is placed in a tank filled with liquid substance, for example, water, which will accumulate the energy of the explosion. The reactor itself has to be cheap, because it will be used once. The scheme of the system is shown in a highly simplified manner on FIG. 1.

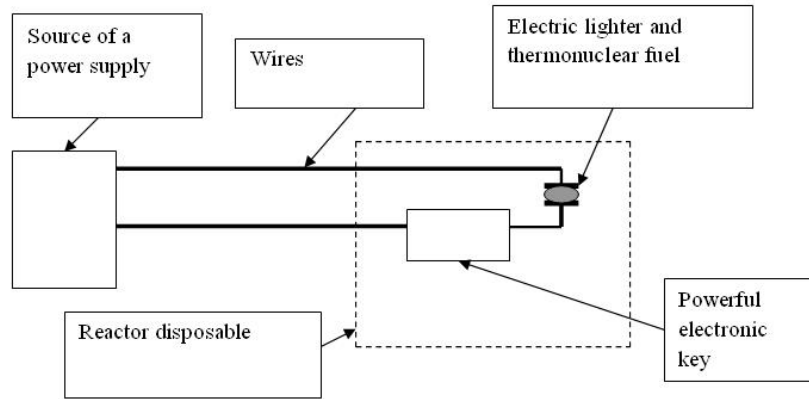


Fig. 1 Electric lighter for fusion reactor

The aim is to concentrate a high density electric current upon a miniature target in which the fuel is located. The reactor (with the electric lighter, fuel and electronic switch) is immersed in a water tank. The fast-acting electronic switch is activated distantly and if the lighter provides the necessary conditions for fusion, an explosion will occur. The irradiated energy is retained in the container, which is designed to withstand the mechanical shock wave. The water temperature will rise significantly. These explosions can be organized in shorter or longer time intervals depending on the needed water temperature. The hot water is then sent to a turbine generating electric energy.

4. IDEAS FOR A NEW TYPE OF ELECTRIC LIGHTER.

The goal is to use the p-n junctions of the collector of a powerful high-frequency bipolar transistor as an electric lighter and fusion reactor at the same time!

We came upon this idea when we tested an electronic switch of a high power step motor, developed by us. The scheme is shown on Figure 2.

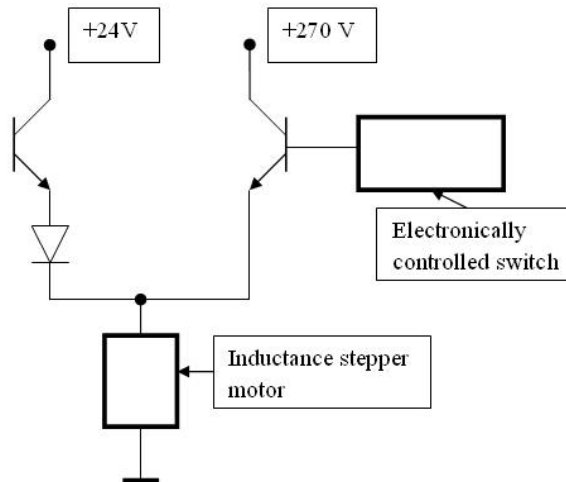


Fig. 2 An electronic switch with inductive capacity.

A high voltage of about 270 volts is initially applied to the main transistor in order to increase the dynamics of propulsion, then the high voltage is automatically turned off and a lower voltage is applied. The electric circuit has a minimum resistance of about 1-2 ohms. If the high voltage, for

some reason, is not turned off, the current passing through the key transistor is increased and it crashes with a slight explosion. Due to the great energy injected into the collector, which is affixed to the chassis, the temperature increases so much that a part of the chassis melts. Meanwhile, the base of the transistor remains soldered to the connecting conductor, which shows that the temperature there does not exceed 100° C, although it is a metal one, it is connected to the collector and is only a few millimeters long.

From this experiment we concluded that the thermodynamic processes in the collector occur at such high speed that the temperature rise in it does not lead to a temperature increase of the base. It also means that a phenomenon, known as a "blast" has been arisen in the collector.

An explosion is called a phenomenon in which a material suddenly and dramatically increases its volume. It is accompanied by the release of enormous amount of energy, gases at high temperature, radiation and nucleons. The explosion cause mechanical shock waves too. In the case of the phenomenon "blast" it is interesting that the kinetic energy of particles in a small volume can be increased significantly prior to the heating of other surrounding areas.

From the above it can be summarized that indeed the temperature may be dramatically increased in a part of the volume, while it can be very low in a nearby part. Furthermore, another very important thing is that even a small amount of energy focused in a nano-volume can cause tremendous temperature increase. The effect is due to two main reasons:

- A very low thermal conductivity of the body;
- The thermodynamic processes occur at such colossal speeds that the time is insufficient for the heat to spread and so no energy is lost.

The second case is typical of explosives. The injection of huge amount of energy in a particular part of the volume leads to a sharp increase in the particles kinetic energy and hence of their temperature, before the heat is spread to neighboring particles. It is known that the mechanical shock wave for the highly efficient explosive substances, such as TNT, propagates at a speed of about 6000 m / sec. Since the process of oxidation proceeds considerably faster, the particles obtain large amounts of kinetic energy before they scatter. Therefore the explosive is in its initial volume until the particles attain extra kinetic energy and begin to scatter. As a result a powerful shock wave is generated, also called detonation.

Therefore, if a flow of electrons (electric current) is injected into the p-n junction of a transistor at high-density (about 100 Amperes) and high speed (1000 Volta) in a small volume (1 cubic millimeter), it is possible that conditions for the appearance of an ultra-high temperature core will be formed, i.e. conditions for micro thermonuclear synthesis. The inner part of the transistor can be covered with lithium, so that a reaction of the type Deuterium-Tritium can proceed.

Such a process is typical of a hydrogen bomb, which unfortunately has a huge devastating effect. In this case the kinetic energy of the deuterium-tritium mixture is pumped from the atomic bomb explosion before particles scattering and before the process of detonation. Therefore, in this case, it is not necessary to have a chassis, called a fusion reactor, with a strong magnetic field, which can retain the heated plasma, and to protect it from heat loss. Aforementioned is true for all other cases, when a large amount of energy with super high speed of the thermodynamic processes is injecting in a limited volume. Reasonably, in our case of electrical current injection through the p-n junction of a transistor in a fusion target, it is not necessary to have a classical fusion reactor. The only thing that must be done is to implant one or more drops of deuterium-tritium mixture in the collector of a transistor. The scheme is shown in FIG. 3.

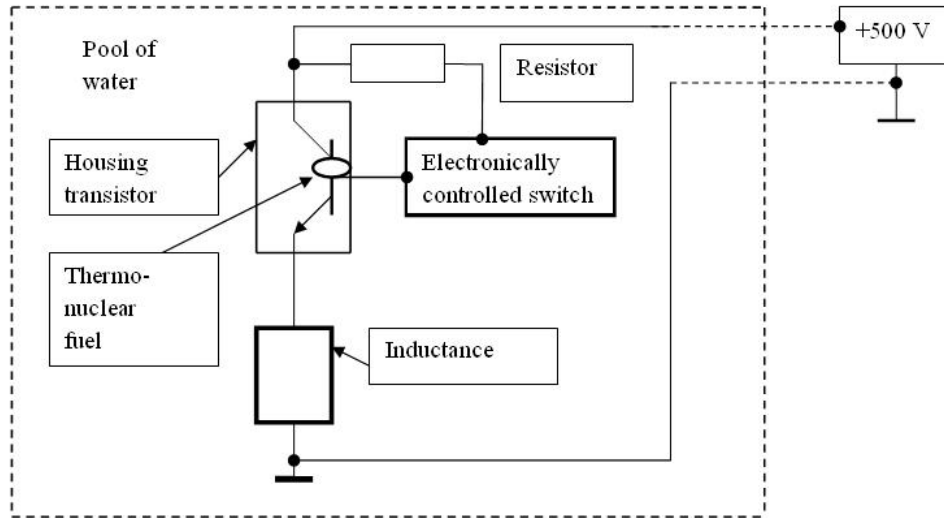


Fig. 3 A design of semiconductor thermonuclear reactor.

The frequency of the explosions is automatically adjusted depending on the desired water temperature.

5. ENERGY AND ELECTRIC EVALUATION OF THE EXPERIMENTAL SET

Having in mind the Avogadro law, we can easily calculate that 18 grams water, or 18 ml of water contain 6.02×10^{23} particles. Then one drop, that averages 1/40 of a milliliter, will contain approximately 8.36×10^{20} particles. Since in a fusion reaction two particles are involved and 17.58 MeV energy is irradiated, then the total energy of the drop would be:

$$E = 0.5 \times 8.36 \times 10^{20} \times 1.6 \times 10^{-19} \times 1.76 \times 10^7 [eV] = 1.177 \times 10^9 [J] \quad (1)$$

The number 1.6×10^{-19} is to translate the energy from electron volt in Joules.

On the other side 1 liter of oil encloses 4.19×10^7 J energy. Therefore, the complete combustion of a drop of deuterium and tritium releases as much energy as 28 liters of oil. This is the total energy released, but how much of it will actually be spent at this stage, is difficult to calculate. The estimation is made for a drop, because that is the maximum amount of thermonuclear fuel that can be enclosed in an ordinary transistor's chassis.

Furthermore, we can calculate the energy required to heat a drop of water to a temperature of 10^7 °C necessary for the fusion. Assuming that 1 ml of water containing 40 drops and that the thermal parameters of deuterium and tritium are approximately equal with the ones of water, we obtain:

$$E = 0.025 \times 10^7 \times 4.19 [J] = 1.05 \times 10^6 [J] \quad (2)$$

This implies that in order to ensure such energy in a p-n transition, a current of 500 A should be injected at a voltage of 2000 V within 1 second. For a comparison, we can mention that a current of 2 to 20 million amps is used in the modern fusion reactors.

Comparing the results obtained from eq. (1) and (2) we perceive that the energy gain is about 1000 times greater than it's lost. Furthermore - the kinetic energy of the plasma particles formed by deuterium and tritium nuclear is transformed and stored in the obtained helium and neutrons, and further in the water reservoir as shown in FIG. 3. This further increases the efficiency of the system. Concerning the losses, there could not be accurate calculations for now, but the reserves are large as can be seen from eq. (1) and eq. (2).

As a conclusion we can state that both the electrical and the energy estimations at this stage are mainly qualitative. We chose a bipolar transistor and its p-n collector, which is controlled by the base, for the location of fuel. The activation of a fusion process is started by an activation signal from the base p-n junction. This transistor has to be a high frequency one in order to provide a rapid increase of the current through it, respectively, a rapid temperature increase. The transistor's output inductance should strongly limit the rate of electron leakage. Thus, a maximum use of the energy is achieved from the electronic injection in the transistor collector. Presently, there is still insufficient experimental data for the successful and detailed construction of the specific electric circuit.

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