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RESEARCH ARTICLE

SOLID PHASE PLASMA ULTRAVIOLET LASER

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Abstract

Plasma ultraviolet laser, as a new option of energy device based on use of phase transitions in plasma, is proposed. Materials for laser can serve virtually any waste that in abundance include lithium, boron, sulfur, silicon, phosphorus, copper and iron; this is shown on the basis of energy calculations. Example of using gas waste (containing those items and entering the smoke alarm) as a plasma emitter by heating it to a temperature of a few thousand degrees at pressure 1 ATM is describes. It is shown that the process the allocation of energy in laser is accompanied by phase transformation of a new kind of substance: first plasma discharge formed plasma liquid, and then (when it is further cooled) formed a solid conglomerate, that is the crystalline formations. Solid plasma phase is a substance with new properties. The authors offer named this new area as the discharge plasma metallurgy.

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Modern energy is in dire need of a medium-sized power source, but the current continuously, ecology clean, and not associated with the consumption of expensive resources. Proposed option of energy device based on phase transitions in plasma should be attributed specifically to the kind of sources [1-3].

In *conventional laser and maser devices* as a carrier of electromagnetic field used atomic and molecular systems. Pumping and radiation carried out with this due to discrete (quantum) transitions between energy levels that are selected in a certain way. We can implement optical and x-ray emission *in plasma* by using a combination of transitions in continuous and discrete spectra of ionic and atomic states. Quantum states of a particular type are possible in *not-degenerate plasma*: they are due to electrons and ions bounds, i.e., the action of the effective force of attraction between particles, the result of which is the formation of the new stable energy levels below the basic levels of isolated atoms. This is due to the action of specific quantum force that arise in electronic exchange bars, and it turns out that the effect of the exchange should consider it is in the continuous spectrum (i.e. in ionized state of matter). To “enable” of quantum forces it is enough that attitude ${}^{\lambda_{б}}/_{r_e}$ totaled the amount $order\ \frac{1}{3} \div \frac{1}{5}$, i.e. it is enough just to “order” approximation of the de-Broglie wavelength $\lambda_{б}$ to inter-electrons destination r_e. This is a specificity of the continuous spectrum of plasma: wave functions of electrons are oscillating in nature, slightly decreasing with distance between atoms, and so the wave functions overlap may be significant.

It was shown that such forces could lead to the formation of new collective energy levels in systems [4, 5]. Similar phenomena (perhaps only and external physical manifestations in relation to the properties of the energy spectrum) have a place in superconductors: conduction electrons that are initially quasi-free are clearly pronounced tendency to

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mutual pairing, consequence of which are the emergence of a Cooper's pair and energy gap in the spectrum, which leads to superconductivity [5].

Plasma level of lowering energy electronic system (negative sign), calculated us order-of-magnitude and based on one electron, is equal to [4]:

$$W_1 = -\,3 \cdot z^2 e^2 n^{1\backslash 3} \Lambda\,,$$

where: z – the degree of ion ionization, n – concentration, e – the charge of an electron in *cgs* units, $\Lambda \sim 15$ – logarithmic factor (type of Coulomb logarithm).

Let us denote by I ionization energy, also calculated for a one electron. Then the above interaction leads to a lower energy level of particles (relatively to atomic) when implementation the inequality $I < W_1$.

Obviously, this condition is relatively easily solved in fairly dense (but not yet degenerate) plasma. The frequency of the transition from a state of continuous spectrum into the lower energy state is equal to $\omega = W_1/\hbar$.

The best way to get excess energy, equal to module $|W|$, is creation of dense gas discharge from a mixture of easy ionized type elements, such as cesium, carbon, nitrogen and other. If we take $n = 10^{19} sm^{-3}$, $z = 5$, that per unit volume (1 $cм^3$) such a mixture will get:

$$|W_1| = 3{\cdot}10^{-16}\ n^{4/3}\ erg \sim 30\ kJ/sm^3.$$

This energy radiates mostly in the lines of the spectrum with energies $\hbar\omega \sim 10\ EV$, i.e. in the ultraviolet range. The duration of radiation are determined by quantum transition. Characteristic length of radiation is determined by the diffusion of quanta. They are approximately equal $\tau \sim 3 \cdot R^2 n\sigma/c$, where $\sigma \approx \sigma_0 n\lambda^3$ – the cross-section of the inhibitory processes, $\lambda = 2\frac{\pi c}{\omega} \sim 10^{-5}\ sm$ – the wavelengths emitted by quanta, $\sigma_0 \approx 10^{-24}\ sm^2$ – Thomson scattering cross-section; from here is $\sigma \approx 10^{-19} sm^2$. The minimum time for radiation is $\tau \sim\ 10^{-7} \div 10^{-8}$ *sec*. Therefore, when the concentration is $n \sim 2 \cdot 10^{19}\ sm^{-3}$ (atmospheric pressure) and single ionization elements such as lithium, boron, sulfur, silicon, phosphorus, copper and iron, energy $W_1 \sim 25\ EV$, that is several times higher than the efforts on ionization.

Thus, materials for laser can serve virtually any wastes that contain these elements in abundance. Enough, for example, take gas coming into the smoke alarm, and use it as a plasma emitter. This requires the following:

1. Collect the gas and heat to a temperature of a few thousand degrees at pressure 1 *ATM*. It is advisable to use at the first stages of compounds easily ionized atoms or molecules.
2. Produce ionization with the help of pulsed electric field with such a breakdown tension, which would ensure the length of run on energy $\ell_\varepsilon \sim I/n\sigma\varepsilon$ when submitting the "seed" electrons with energy $\epsilon \sim 10\ kV$, where $\sigma \sim 10^{-16}\ sm^2$ – elastic scattering cross section, where we can purchase energy order starting, which would enable the development of discharge with subsequent ionization.
3. Implement the transition (under the influence of quantum exchange forces) to the lower energy level, which is accompanied by radiation quanta with frequencies $\omega \geq W_1\hbar \sim 10^{17}\ c^{-1}$, i.e. already in the soft x-ray region. An increase in concentration and charge lead to radiation of harder quantum. This radiation, it seems, we are seeing in a number of plasma elements (for example, when pinch effect, explosive or drip emission, etc.) [6, 7].

The proposed laser mechanism differs from other known, primarily because pumping is carried out at frequencies lower operating frequency. An important feature of plasma ultraviolet laser is that the energy of the laser radiation will be charged not from an external source (pumping), but represents the internal energy of phase transition in the plasma.

Plasma laser devices are completely safe; risk relates only to normal working with the technique of high voltages. Materials that are used are mixtures of light elements; they are very cheap, any extra costs to receive them are not required. As laser fuel we can use *garbage* (in the literal sense of the word), effectively "burning" it for the production of laser energy.

It is not excluded that this (use of waste, "soul-searching", even wrestling for waste) will be characteristic of civilization of the twenty-first century. Appliances, like nature, must be rational. Another important fact is that *the process of energy production is accompanied by the phase transformation of the substance of the new species*.

Firstly from plasma discharge the plasma liquid substance is formed, and then, when it cools later, *a solid conglomerate (crystalline formation) is formed*. We meet with this kind of transformations, for example, when volcanic eruptions. We assume that the hard phase plasma is a substance with any new properties that are not predictable in advance. Anyway, we get new very useful materials when end “combustion” process.

This area of technology can be called *the discharge plasma metallurgy*.

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