STARTEF srl
Viale Umbria, 78
MILANO 20135

200622.EDT-E

EDT CONCEPT SYNTHESIS

Conception

On the basis of concrete realizations aimed at removing heat from the cutting edges of tools, in hard metal, for high-speed milling without using liquids or cooling fluids and after in-depth conceptual research in the field of emerging nanotechnologies, the possibility of creating a nanometric coating capable of rapidly transporting thermal energy (hot or cold) avoiding the natural dispersion in the air and / or adjacent objects and then converting it into electricity.

EDT (Zero Emissions Electricity) is designed to produce electricity, without any harmful emissions, using thermal energy, hot or cold, captured by the surface with EDT coating.

Precisely the high value of thermal conductivity (physical characteristic of the coating molecule) allows the transfer of the captured thermal energy, without appreciable dispersion, to a suitable group of thermoelectrics (according to the Seebeck principle) generating electricity that will be conformed, through a dedicated electronic group, for normal use and / or networking. In the case of a negative gradient (ie: below zero) the voltage value will have the opposite sign with respect to what is obtained with a positive gradient. The electronics will reverse the polarity so that it will be obtained, however, electricity conforming to normal use.

The power of electricity generated is a function of the thermal gradient and the size of the surface (with nanometric coating) designed to capture the thermal energy present in the surrounding environment.

In any case, the applications and uses of the cladding are many: it can also be used for the rapid cooling of electronic circuits (to improve their performance and / or their lifespan as well as their reliability), but can, however, be used in all cases where it is necessary to create preferential lanes for thermal energy, hot or cold, avoiding the inexorable dispersion in the surrounding external environment.

EDT is imperatively characterized by the high thermal conductivity of the nanometer coating molecule. In nature the high thermal conductivity is a prerogative of the Diamond and therefore the researches have been carried out looking for industrial means and methods to reproduce rationally the Diamond molecule respecting the following imperatives:

- ⇒ Little energy spent;
- ⇒ Possibility to carry out the coating on many substrates, both rigid and flexible;
- ⇒ Making objects coated at low cost;
- ⇒ Carry out the coating process in any country in the world including countries without developed industries and staff without school qualifications;
- ⇒ Respect the environment!.

The literature reports examples of DLC (Diamond Like Carbon) coatings made with magnetron Sputtering.

After in-depth studies, principle experiments and related simulations (based on experimental data), it was decided to move to the basic experimentation: to realize the coating (nanometric) with high thermal conductivity on different substrates starting from those in stainless steel AISI 304 (low thermal conductivity).

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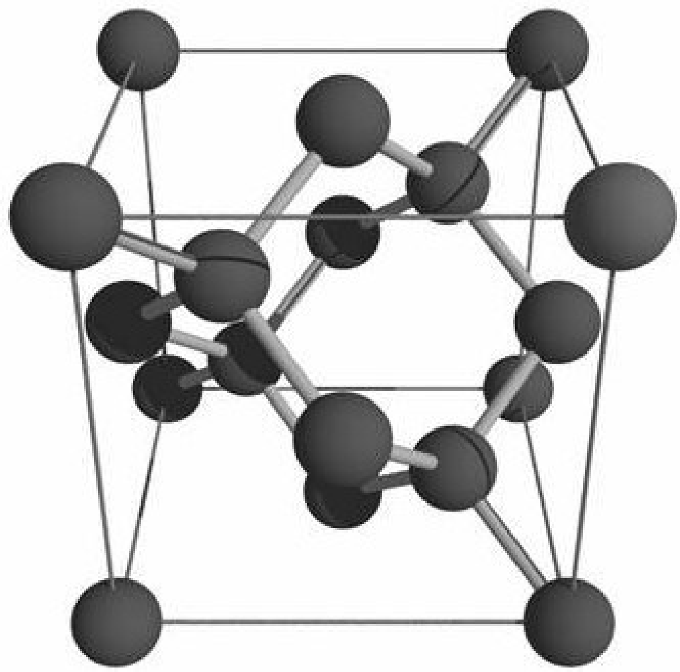
Basic experimentation

According to the aforementioned studies and simulations, some "Sputtering" processes and related methods to be tested have been defined.

In order to have the maximum thermal conductivity, the coating must be very similar to the Diamond. Resuming what was mentioned for the DLC, it has been said that it is an amorphous form of carbon.
In it alternate zones in which the carbon takes the form of graphite (sp^2 bonds) and areas in which the diamond structure prevails (sp^3 bonds).
It is clear that the purpose is to obtain a coating in which the tetrahedral structure of the diamond prevails.



From the experiments, confirmed by the literature, it emerged that the total thickness of the coating will be constructed by overlapping so many layers .
In fact, if we wanted to make a single coating we would generate a lot of stress so as to cause the coating to break (cracks).
Moreover, again due to the high stress, high temperatures would develop in the coating under construction favoring the formation of sp^2 bonds.
In substance we have seen that the best solution is to proceed by overlapping many sp^3 layers interspersed with layer sp^2. The sp^3 layers will be thicker than the sp^2 layers which will be very thin instead.

After numerous experiments it has been established that it is essential to overlap several sequential layers to obtain a predominantly sp^3 (diamond) coating without breaks (cracks).
The realistic possibility of obtaining a coating characterized by high thermal conductivity, transparent, making it possible to cover window glass
The need to manage the various parameters (voltage, power, frequency, vacuum, gas, etc.) according to the substrate, the thickness of the coating and its specific characteristics (hardness, thermal conductivity, transparency, etc.) has been established.

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The experiments were performed with 99.9999% pure graphite Target and according to different recipes. For each recipe we proceeded to obtain thick coatings as follows:

⇒ 300 nm;
⇒ 600 nm;
⇒ 1 µm;
⇒ 3 µm;
⇒ 6 µm;
⇒ 10 µm;
⇒ 20 µm.

Nanotube deposition has also been tested. Given the need to use Target containing a small amount of Ni (nickel) it was decided not to pursue the Nanotube hypothesis.

Subsequently, testing was also carried out (strictly with Carbon, 99.9999% Target Graphite) on a carbon fiber substrate with continuous fibers, creating a 200 nm coating. The analysis of conductivity surveys carried out on this sample makes it possible to state:.

- **The Thermal conductivity value of the EDT coating is equal to** : **1570** $w*m^{-1}*k^{-1}$

Conclusions:

⇒ It confirms that the "EDT" objectives, related to the wide range of coating substrates (rigid, semi-rigid ÷ flexible) with the desired physical characteristics of thermal conductivity, are realistic;
⇒ Confirmation of the possibility of making coatings, of limited thickness, characterized by high thermal conductivity and transparency so as to allow the application for windows.
⇒ Confirm that the coating processes are feasible using only carbon (Graphite Target);
⇒ It confirms that the processes take place at low temperature with little energy and therefore with a high EROEI ratio (yield energy / energy expended) = 2000 ÷ 5000 depending on the thermal differential;
⇒ Confirms that slabs or panels with EDT coating, by rapidly transferring the thermal energy (hot or cold) that impacts on their surface, also perform, significantly, the function of insulating;
⇒ It has been defined that the thickness of the coating, multilayer, for a thermal differential not exceeding 50°C will be 200 nm ÷ 6 µm..
⇒ We highlight the need to study a new type of automated "Machine Sputtering" to make the industrial system highly productive;
⇒ We highlight the need to study and prepare a specific type of electronic groups, integrating a specific Boost-Buck device, in order to improve efficiency by converting even small amounts of energy into electricity (when the gradient is very small).
⇒ Industrialization, with advanced automation, must take into account that for production it is possible to employ personnel without qualifications who have simply attended and passed a specific training on procedures and operating procedures.

Theoretically there would be other possibilities to realize physical characteristics of high thermal conductivity but only on some specific substrates and with a lot of energy expenditure for raw materials and for the process itself.

EDT CONCEPT SYNTHESIS

In any case we can summarize:

Disadvantages of the "EDT" system:

⇒ Need for special machinery, not available on the market ready for use, to carry out production with the necessary functional and qualitative characteristics;

⇒ Need for specific training of production personnel for learning operational procedures.

Advantages of the "EDT" system, summarized as follows:

⇒ "EDT", with characteristics of high thermal conductivity, is achievable on many types of rigid or flexible substrates on the sole condition that the material they are made of bears at least the temperature of about 65° C *(65° C are necessary for washing using ultrasound in water to avoid chemical solvents - during the coating the temperature remains within 50° C)*;

⇒ The life of the "EDT" coating is practically infinite; it will maintain its specific physical and functional characteristics until the substrate exists;

⇒ "EDT" can be transparent without significant reductions or deformations of the light rays passing through it;

⇒ "EDT" withstands a very wide temperature range ranging from very low temperatures of -100 ° C to about 1000 ° C;

⇒ "EDT" can be applied anywhere and is resistant to any chemical aggression;

⇒ "EDT", being independent of light, can be applied in any position and can cover substrates of any color. *If applied to the external walls of a building (using panels or slabs), it will produce electricity by significantly reducing the transfer of heat or cold to the wall itself.*

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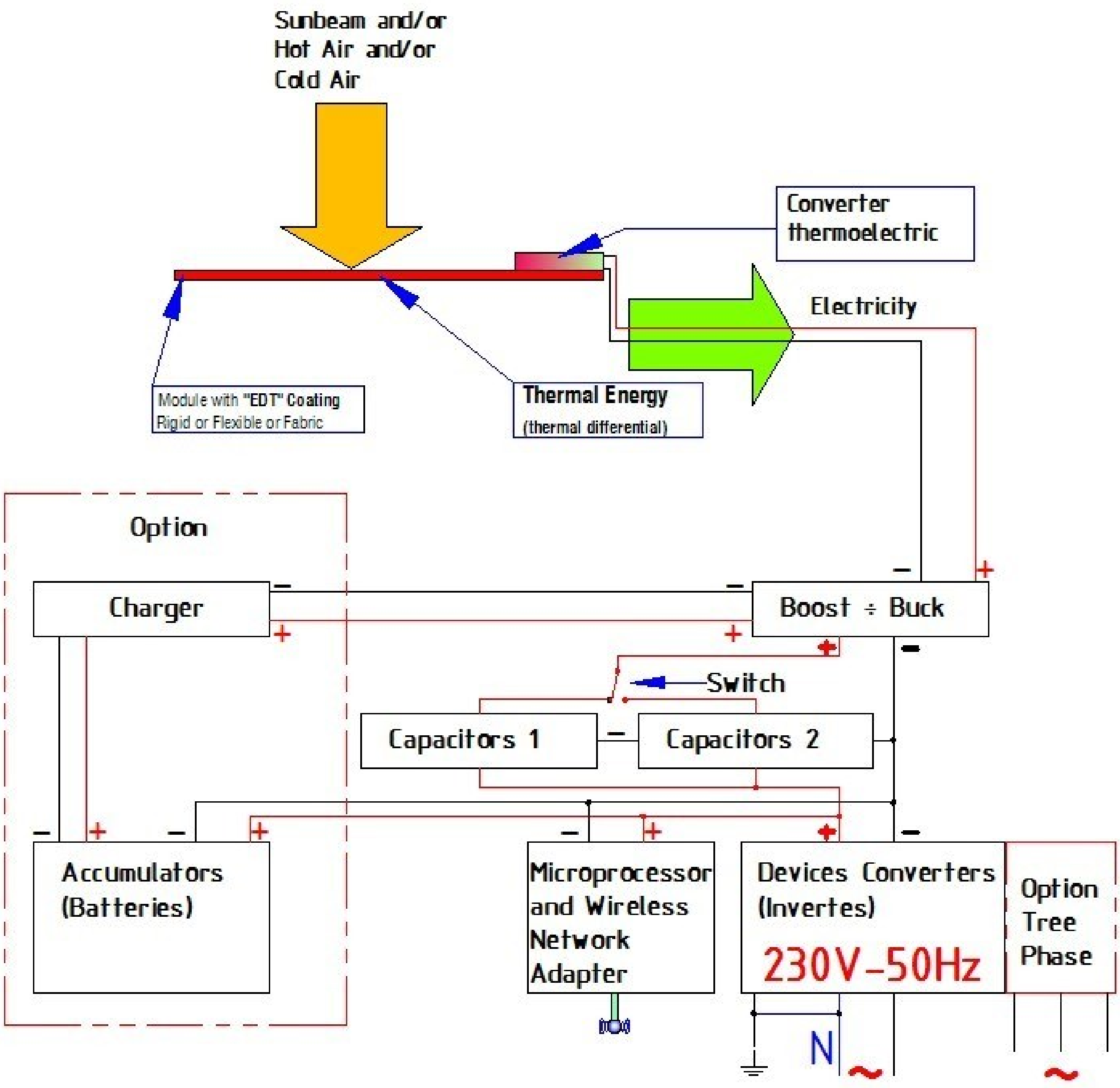
Electronic conversion device

The electronic groups dedicated to the conversion of thermal energy into electricity will be designed according to the following principle scheme:



The Boost-Buck device, which is essential to be able to use even the smallest amounts of energy available when the thermal differential is small, must imperatively be made with high-efficiency elements.
For each m² of EDT coating, 50 cm² must be used for the conversion thermoelectric systems.