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Content

ABSTRACT

Nowadays, the reserves of non-renewable energy are being consumed more rapidly than ever due to the increased energy demands. As a result most of the existing energy resources have reached the limits of exhaustion. Meanwhile, due to the air pollution caused during their combustion, they are harming the environment, damaging the ecosystem and jeopardizing our health. You have probably heard of the Greenhouse Effect. Effective energy conservation can only be achieved through rational and efficient use of the existing energy reserves.

By saving energy, neither do we reduce, nor do we eliminate our energy demands. On the contrary we ameliorate our living standards. Our proposal, aiming towards those directions, is related to the application of a new "eco-friendly" method of exploitation of renewable energy resources. The photovoltaic effect, the piezoelectric effect and the superconductivity through the use of a new ground-breaking science, nanotechnology, seem to be interesting and financially viable and efficient solutions. Thus, we designed and "gave life" to our though by a nanostructure that combines all these scientific effects (the photovoltaic effect, the piezoelectric effect and the superconductivity). Our primary source of energy was solar radiation and any form of mechanic voltage. As a result we manage to satisfy, to a great extent the energy demands of our school (heating/air-conditioning-lighting). We encourage the scalability and implementation of our concept and other public places.

1. INTRODUCTION

Humanity is confronted to an energy source deprivation and to an extended economic dysfunction. The energy problem in the world nowadays consists of three basic components. As far as the environmental factor is concerned, energy production has a catastrophic impact on nature, let alone that highly efficient forms of energy are in very short supply and their over-exploitation destroys the local ecosystems. Furthermore, the fact that thousands of people are added in the world population monthly makes it very likely that we are about to face further problems in the future. Most of all, even in the western world, in countries like ours, much of the population gets too little energy to meet the basic human needs, as they are recreated by the technological revolution; given thatthe monetary costs of energy are rising nearly everywhere.

This enormous reduction in the consumption of energy, in the era of economic hardships, affects the educational process. Schools in Patras, like ours, do face a huge energy problem. Central heating is on for a few hours in the morning, only during the unbearably cold days, making the school environment unpleasant and unhealthy for both students and teachers. Still, the energy consumption remains very high, forcing us to cut on further investments on education. Plus, the unbearable heat in the early September and during the summer exams can no way be addressed with the technological and financial means of which we dispose now, as the installation of air conditioning systems constitutes an unattainable dream. Sadly, such problems do not seem to be amongst the priorities, given the political and financial situation in our country, and the fate of Greek schools remains uncertain [9].

As a society, we cannot afford to spend more money on energy, and we cannot risk damaging the environment irreparably. It becomes our responsibility; it's up to us, as a student body, to come up with alternative, environmentally friendly and money saving ways to produce our energy, contributing to the self-sufficiency of our school. So why not use all this challenges as an inspiration? Green nanotechnology can help us reduce pollution from energy generation and help conserve fossil fuels. Modern challenges require modern ways of facing them. Nanotechnology is evolving constantly, getting better day by day, and will help us reduce pollution from energy generation and conserve fossil fuels [13].

We suggest exploiting the constant movement and sound produced daily in our school, during lessons or breaks, in the gym or in the corridors, in order to generate the energy needed for its daily function. We imagine our school walls and floors coated by layers, which will have the ability to convert the nanoscale mechanical energy into electrical energy by means of piezoelectric zinc oxide nanowires, with the prospect of expanding the use of these exagonic nanodevices outside the narrow "borders" of our school and our town.

2. NEW PRODUCT / SERVICE DESCRIPTION

The origin and historical evolution of nanotechnology are unknown. The first nanotechnologists might have been glass workers who used ovens in order to shape glass objects.

The first scientific report on nanotechnology (without the use of that name) was in a speech made by Richard Feynman, 1959, entitled "There's plenty of room at the bottom".

The term Nanotechnology [23], [24], [25], was first used by the Sciences University of Tokyo professor, Norio Taniguchi in 1974 in a thesis entitled "On the concept of Nanotechnology" to describe the precision of material manufacture with nanometer tolerances.

Photovoltaics & Nanotechnology

The general term “photovoltaic” [7], [8], refers to the industrial lining of more than one photovoltaic cells. In essence it is artificial semiconductors (usually made of silicon) which are combined in order to create an electrical circuit in series. These semiconductors absorb photons through solar radiation and produce an electrical voltage [3]. This process is otherwise known as the photovoltaic effect. The photovoltaics belong in the category of renewable energy sources. The currently existing photovoltaics in Greece are devised in two generations.

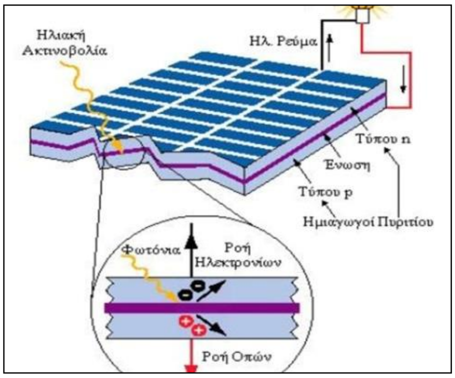

Figure 1

The first generation (PV/W) of photovoltaic elements is based on the traditional technology of silicon. On the contrary, the second generation of photovoltaic, used nowadays, mostly in Greece, is based on the use of thin films [21]. As a result, products that belong to the second generation are far more competitive in terms of performance. Aside from that factor, these products possess various other important manufacturing advantages such as less material consumption, fewer steps for completion and easier automation. Therefor, it is obvious that photovoltaic improve thanks to the use of thinner and smaller materials, thus the creation of the third generation photovoltaic. Third generation photovoltaic are already being used in shelters in Los Angeles and are expected to be applied to bus stops through-out Berlin. The special feature of this category of photovoltaic, their key difference from the other two, is that their manufacture requires relatively low quantities of cheap materials. Goal of the development third generation photovoltaic is a mass production of flexible photovoltaic (thin film) with high levels of performance and various application possibilities. For the time being, research is conduct in order to find ways to maximize the performance of such photovoltaic. According to Dr. Constantine Fostiropoulos, a valuable advantage of third generation photovoltaic is that they are expected to be 50% cheaper than those of the second generation that have been launch to the market up till now. Apart from their low cost, in comparison to the cost of silicon technology, they also offer a high level of energy automation and they are they are more elegant in terms of appearance.

Nowadays [22], researchers are focused on increasing the levels of performance of photovoltaic cells through the use of nanotechnology.

By using nanoparticles of germanium, silicon and other materials [11], researchers aim to produce photovoltaic cells even more efficient, with levels of performance up to 65%. Traditional photovoltaic cells function according to the principle: “A photon in- an electron out.” In other words, each light particle, each photo in this case, that enters the photovoltaic cell, produces an electron and in that way we have the production of electricity that is received as an exit.

In theory, according to this theory the maximum performance of a photovoltaic is 31%. However, by creating photovoltaic cells from very small nanoparticles, scientists aim to achieve a correspondence of far more than one electrons to each photon. Scientists estimate that such a method will lead to a maximum performance that will range between 42 to 65%.

An example of combination the photovoltaic effect and nanotechnology are photovoltaic awnings which will channel and convert the solar radiation they will absorb into other forms of energy that are necessary for the function of various electrical appliances.

Piezoelectric Effect

The piezoelectric effect [6], [7], [12], was discovered by Pierre and Jacques Curie in 1880. It is described in the property of certain materials (mostly crystal but some ceramic as well) to produce electrical voltage as a result of applying certain mechanic pressure or ooscillation. Piezoelectric can be explained qualitatively through the transportation of free charges at the ends of a crystal mesh. Piezoelectric materials belong in the category of intelligent materials. These materials are known for their satisfactory response to stimulus of various natures.

Generally, the piezoelectric effect is anisotropic, in other words, it appears in materials with crystal structure without center of symmetry, and it is a first class effect [10]. In the case of certain ceramic materials, if placed in certain temperature conditions, or else known as Curie Temperature [2], they create inside the crystal electric dipoles of random orientation that are macroscopically inexistent [4]. During the polarization process, in presence of a strong electric field, these dipoles tend to form a line, leading macroscopically to the creation of an electric dipole. After the cooling process and the removal of the polarization field, the electric dipoles cannot return to their initial positions and the material has become permanently piezoelectric, thus it can convert mechanic energy to electric energy and vice versa. This property is lost only if the the temperature differs from the Curie Temperature, or if the arrangement is submitted to a very strong electric field [2] .

Certain examples of materials with piezoelectric properties [18] are quartz (SiO2), Rochelle salt or Seignette (tart rate, NaKC4H4O6·2H2O), the ADP (ammonium dehydrogenate phosphate, NH4H2PO4), lithium sulfate monohydrate, (LiSO4.H2O), tourmaline, the synthetic polymer is PVDF (polyvinylidene difluoride), etc.

Zinc oxide

Zinc oxide is an organic compound, a white powder, which is insoluble in water. Used in countless materials and products. As a naturally occurring mineral, but the bulk of the produced artificially. The crystals of occurs in three forms, the hexagonal structure of vourtsiti (thermo-dynamically more stable in ambient environment and most common), the pentagonal structure of sphalerite (stabilized if the ZnO grown on a sub-strate lattice with cubic structure) and structure [7] of the salt. The dominant form is hexagonal.

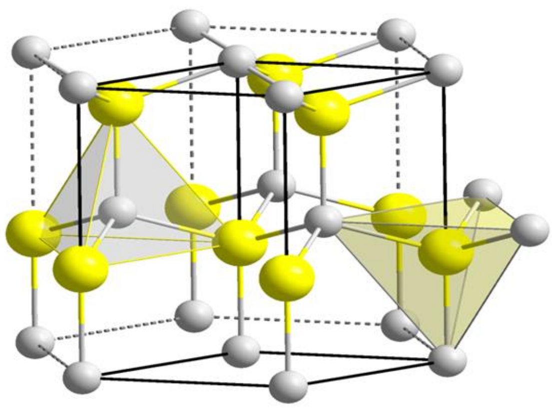

Figure 2

The structure of wurtzite shown in the figure 2. In an article recently published in Nature, scientists from the Institute of Technology "Georgia" developed nano-wires of zinc oxide around kevlar fibers.

The researchers placed the fibers together: when the wires rub against one ano-

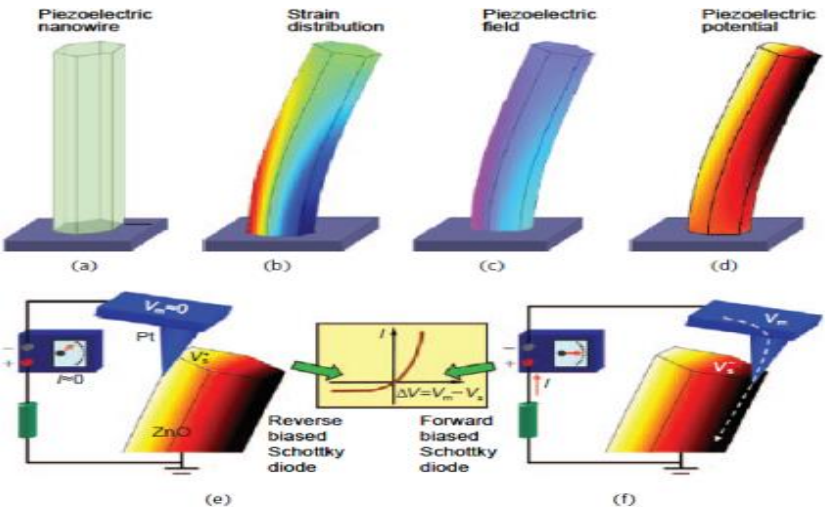

Figure 3

ther, creating an electric charge, whose motion is produced in the output stream.

The ZnO has applications to piezo-electricity [8]. The piezoelectric proper-ties due to tetrahedral crystalline structure, in which the ties between individuals are very strong. Given the lack of central symmetry which characterizes, the center of which is composed of positive and negative charges, may be moved due to external pressure, which will induce a field distortion. This shift has resulted local dipole moments, so a macroscopic dipole moment occurs in the crystal. Among the tetrahedral crystal, the ZnO has the highest piezoelectric vector that provides high electromechanical coupling.

The piezoelectric property of ZnO nano-structures has yet to be investigated for a beneficial applications of nanoelectro-mechanic systems. Moreover, the structures of ZnO have results and creating nano-rings and nano-coils.

Superconductivity

Superconductivity is the state in which a material (usually metal and ceramic) have zero ohmic resistance. Materials that are insulators have high resistance, while materials that are conductors have little resistance [25]. These materials are called superconductors. In a superconductor collisions between electrons and atoms are minimized with the result that electric current flows unaffected and without any difficulty. The temperature below which a material is called the critical temperature superconductor. For most metals the critical temperature is close to absolute zero. So far there has been superconductor at room temperature, a discovery that probably would have dire consequences in the technology industry.

Interpretation

Superconductivity is considered a quantum phenomenon and rarely explained by classical physics. Electrons are the natural hosts of the electric current in the conductors and the scattering in the crystal lattice (and generally the material) of the conduit, during the forced passage through it, causing the brakes and thus appears ohmic resistance [30]. The scattering of electrons are on the atoms of the crystal:

a) due to the lattice defects (impurities, gridded spaces) that deform the crystal, and

b) due to the non-zero temperature of the crystal from which his men oscillate and occupy larger space statistics and thus shortens the free (by scattering) parking pass for electrons .

In terms of superconductivity things work differently. Individuals in the crystal principle no longer oscillate strongly due to the low temperature and the grid gaps are closing. But it is not a necessary and sufficient condition for this appearance of superconductivity.

There are several mechanisms, depending on the material, giving superconducting properties in combination lattice - electron.

Properties of superconducting materials

The property of superconductivity occurs for specific maximum amperage and magnetic field strength. Another important property of superconducting materials is the repulsion of the magnetic fields (apparent Meissner). The magnetic permeability is very small, i.e., the magnetic field penetrates quite difficult in a superconducting material [26]. The penetration of the magnetic field into a superconducting material destroys the superconductivity.

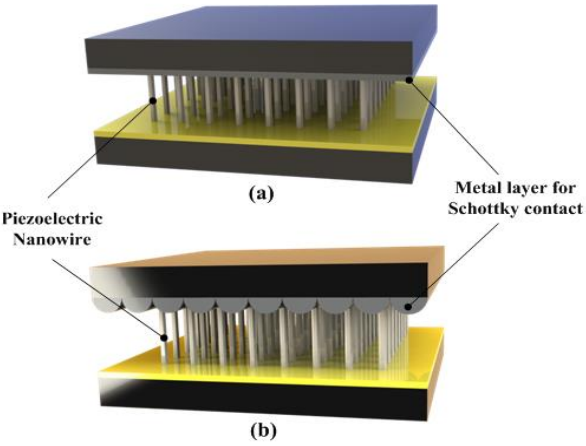

Figure 4

In metallic superconductors superconductivity is destroyed just begun to penetrate this magnetic field.

This penetration is not homogeneous in ceramic materials, but about heads, ie the magnetic field lines follow specific paths through the material and around these trails does not penetrate the magnetic field . Normal penetration magnetic field is in ceramic materials for strong magnetic fields.

Applications

They have built in temperature superconducting materials a few dozen degrees below zero in powder form. This powder is used for manufacturing superconducting wires of a relatively small length which are used in nuclear reactors [27], [29].

There are applications based on the phenomenon Meissner. The superconducting material used in magnetic shielding electronic and magnetic suspension.

Nanostructure description

This nanostructure is categorized as an energy converter, also fulfilling the requested needs for transportation of the energy. It is designed to convert mechanical and solar energy into electrical energy, using the piezoelectrical and photovoltaic phenomenon. Right after the conversion, it is capable of transporting this amount of electrical energy and deliver it to its destination, with near- zero losses [33].

The structure of this nanosystem mainly consists of two different parts, viewed as different layers of materials: the solar-to-electrical energy conversion part and the mechanical-to-electrical energy conversion part. The energy transportation part is built within the photovoltaic system, so there is no need to be considered as a separate part of the nanosystem [3].

The shape of the nanosystem is a hexagonal prism. This particular shape offers great mechanical properties, such as a high degree of strength and also leaves no empty space, if the units are placed side by side (as each side of the hexagon is touching another hexagon's side, six units are attached to each particular unit). The length and the distance between the sides of the prism does not need to be defined exactly, as it varies according to the needs of the client.

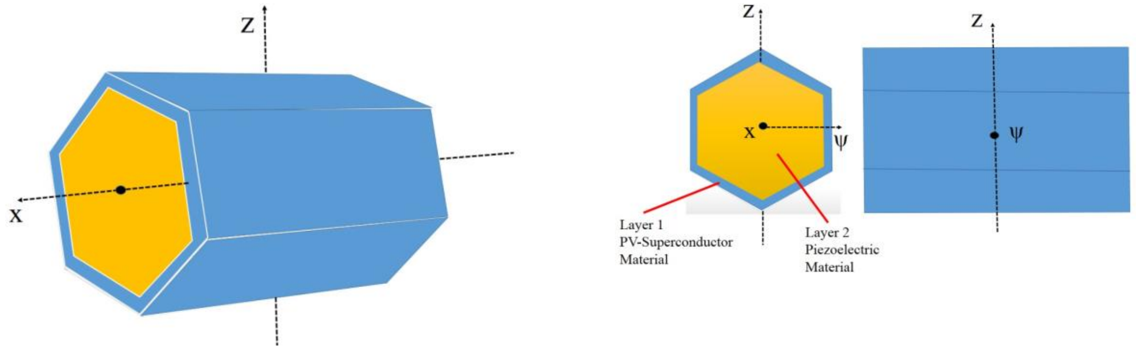

Figure 5

The first part of the nanosystem (the photovoltaic and energy transportation system) is located on the surface layer of the nanostructure and consists of a superconducting, photovoltaic polymer. This material is designed, not only to convert the solar energy into electrical power, but also to transport it with minimal resistance. By the time that solar rays are absorbed by this material, electric current starts passing through the superconductor, being transported to the full length of the surface of the nanostructure and to other similar nano units as well (as they are in contact, as mentioned before). Needless to mention, the superconductor presents a high "critical temperature" , and does not need to be hypercooled in order to gain its superconducting properties. Also standard methods of photovoltaic cells manufacturing are followed, in order to create the necessary p-n junction – small amounts of other materials mix with the main photovoltaic material to create a "p" and an "n" material, and a thin "contact line" to separate them is created [1].

The second part lies deeper, within the second layer and consists the main and most important part of the nanosystem, its core. Here, the material used is a piezoelectric, crystal – type material. It plays its role as a "filling", as it fills up the empty space inside the nanostructure. In order to produce electrical power, the piezoelectric material needs to receive waves of mechanical energy. Consequently, when a wave of this type hits the surface of the nanostructure, it travels through the first layer until reaching the piezoelectrical filling. When it reaches it, the wave's mechanical energy converts into electrical power, which is transported to the surface, where the superconductor takes care of the efficient delivery of the energy [32].

After the electrical energy production, the produced power will be used instantly, stored or transferred directly to the general power network.

Industrially, this nanostructure will be manufactured as a coating powder, as a textile, or inside a liquid solution [4].

These are the default, standard and absolutely basic options of the specific product. The nanostructure is designed so it can be improved, by using "add-on" modules or chemical substances. This is a great advantage, so we can develop different versions of the very same nanostructure, so it can accomplish its task under different conditions. So the possible applications of the nanosystem are practically infinite.

Main upgrade: the Main Upgrade is the process where the majority of produced units will be enriched with a number of substances that will protect the nanosystem from environmental factors, such as water, UV rays, toxic agents, etc. It is considered as a basic process and it is strongly recommended for every client that uses the nanosystem. The Main Upgrade will also prevent any unwanted process from taking place and at the same time, it will protect the environment and the human societies. The Main Upgrade is executed by the manufacturer and industrial producer of the nanosystem [14], [15], [16], [17].

POSSIBLE APPLICATIONS: The nanosystem is designed in such an innovative way, in order to be able to fit theoretically everywhere. An, add-on hardened, nanostructure with the capability to produce energy out of "nothing" and able to replace older power networks with low cost and efficiency, is a really attracting idea with nearly countless applications [19]. The general idea is based on a specific logic: if you apply mechanical pressure on a surface coated with the nanosystem, which can absorb solar rays at the same time, you are producing electrical power. An example application of the nanosystem is the school building: external walls, internal walls, corridors, staircases and classrooms are the recommended locations for coating, because maximum mechanical pressure and solar radiation is expected [5].

Also, the nanostructure will be used as the main construction material for the power transportation network, replacing older, conventional systems.

Some other applications are displayed below:

Aerospace: the nanosystem will be used as a covering material on aircrafts' wings, fuselage, and other external parts. Air's pressure on these surfaces and the absorption of solar rays will lead the nanosystem to produce electrical power. The same basis will be used on space rockets and satellites (especially in satellites, as the nanostructure will allow the transformation of solar energy into electrical power without the need to use solar wings and as a result, cost will be reduced). The electrical energy produced will be used to power several subsystems of these machines [28]. Add-ons can be used to give the nanostructure additional capabilities, such as thermal shielding, ballistic protection, EM protection, radioactive protection, etc.

Civil Engineering: in this sector, the nanosystem will be used along with add-ons, in order to present structural stability and strength against environmental factors, so that it can be used in buildings, bridges, roads, rail tracks, and other similar structures. It will provide these structures with the capability to transform considerable amounts of energy 24 hours per day, as even the smallest ground movement will be exploited by the nanosystem to produce energy. This also means that human movement on these surfaces will produce energy. Also, the nanosystem will be producing electrical energy all-day long, by absorbing solar rays. Standard electrical installations will be considered useless too, as the nanostructure will transport the electrical power where it is needed. Moreover other systems will be replaced by the nanosystem, for example, standard public lighting will be replaced by fluorescent nanosystems [20].

Electronics: TVs, smartphones, computers, and generally, modern electronic devices, require important amounts of energy to work properly. As a result, autonomous charging would be a great feature for them. Here the nanosystem will be mainly used as the primary construction material of these devices. The longer their daily users use them, the greater the amount of energy produced. A smartphone is a representative example of this "use & charge" logic [31].

Railways & Automobile: External surfaces, internal surfaces, mechanical parts, and all other locations of these vehicles where mechanical pressure and solar rays are expected, will be coated with the nanosystem, in order to produce the highest amount of energy possible.

Shipbuilding: ships' and submarines' external surfaces and other parts of the ship, like the living quarters, (where movement and solar rays are expected), will be coated with the nanosystem.

Energy producing facilities: hydroelectric plants, solar energy facilities, wind turbines and coastal wave powerhouses are some excellent places of application of the nanostructure, as, if used, it will act as an auxiliary, power loss – preventive, energy producer.

Clothing and shoes: the nanosystem is built-in the clothing apparel, in the form of textile. Energy is produced with every single move of the body and also, walking is now transformed into a standard, reliable way of energy production for the satisfaction of instant needs (the charging of a cell phone for example).

3. CONCLUSIONS

Nanotechnology is, with no doubt, a vast scientific field that has developed swiftly. It seems as if the future of nanotechnology resembles to a certain sort of science fiction. In terms of energy production, nanotechnology can be applied in various ways.

Through the description of the nanostructure depicted above we attempted to focus on the photovoltaic effect, the exploitation of the piezoelectric effect and superconductivity.

Inspired by the current hearting problems in our school community, we designed and produced our own nanoproduct.. After coating each and every surface of both the interior and the exterior of the building, our school is now functioning on environmentaly friendly, alternative energy which we produce on our own.

Apart from solving all the economic difficulties we faced, we do feel active citizens and part of the contemporary eco-movement, contributing to the preservation and the well-being of the local and global climate.

We do hope that our achievement is accepted in the global community.

The mass production of this design will not solve the global energy problems, but it will be the ultimate low-cost proposal for a “greener” and efficient electrical energy production. As a result, future needs on the production and the transportation of the electrical power will be more easily fulfilled.

We assess that the evolution of new innovative and revolutionary sciences and technologies, such as nanotechnology, can offer opportunities in term of financial improvement, the creation of new industries two things that are vital to our country, especially these difficult times of recession. It appears that traditional industries are becoming fewer and fewer and international. As a result the exploitation of nanotechnology through entrepreneurial activity could be an opportunity for the Greek economy.

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