the dielectric. The area with minimum electromagnetic damping is coupled with at least one area having a different resonance frequency. This area is defined by the boundaries of material property changes, and at least one 2D-3D resonator is arranged in the area exhibiting a different resonance frequency. While the 2D part of this resonator is arranged in the incidence plane, its 3D portion is located in the dielectric, and the last structure having a different resonance frequency is coupled with the solar system in the direction of the electromagnetic wave propagation.

The creation of high-value components of the electric and magnetic fields can be realized conveniently when the 2D-3D resonator is composed of two parts, of which the first (2D) part is constituted by a transformational ~~element~~component arranged on the incidence plane and consisting of a pair of electrodes in the form of coupled conductors, while the second (3D) part is constituted by a dielectric and a reflector arranged both inside the area without electromagnetic damping and inside the area through which the electromagnetic wave passes in a no-loss manner; the transformational ~~element~~component is further arranged on the dielectric, upon which the reflector is placed orthogonally.

The invention utilizes the spectrum of solar radiation in which the electromagnetic wave power flux density ($W/m^2$) is high. Within the presented invention, the solar element in the form of a 2D-3D resonator arranged on a layered dielectric structure is, for the selected portion of the spectrum, tuned to the frequency of the incident EMG wave. The element is tuned in such a manner that it focuses on areas exhibiting high values of power spectral density (such as the infrared radiation areas A, B, C, D); simultaneously, another 2D-3D resonator is tuned to a different frequency of the selected region of the spectrum. This resonator then follows the preceding 2D-3D resonator in the direction of progress of the incident electromagnetic wave. Through such inclusion of other resonators arranged in layers or areas (even though theoretically an infinite number of resonators can be included, the real number remains within several hundreds of these elements), a system of 2D–3D resonators could be built depending on the geographical and climatic conditions; thus, it is possible to exploit the incident electromagnetic wave to acquire the maximum of energy for subsequent conversion into electric energy. In comparison with the currently applied solar and photovoltaic elements, the manufacturing technology and design of the resonators described herein provide for long operating life and allow high thermal differences. The concept realized within the

Exemplary Embodiment of the Invention

The principle of the construction of a solar element with a resonator arranged on a semiconductor structure will be clarified by but not limited to the examples provided below.

The basic version of a solar element with a 2D-3D resonator arranged on a dielectric is provided in Fig. 1. This form of the solar element includes a layered dielectric structure. This structure is formed by the area **5** with minimum electromagnetic damping; the structure is limited by the boundaries **6** of material property changes and by the area **20** exhibiting a different resonance frequency. Furthermore, the area **5** with minimum electromagnetic damping includes at least one 2D-3D resonator **4**. At the location of the incidence plane **3** on the surface of the area, the 2D part of the resonator **4** is arranged; the 3D part of the resonator occupies a portion of the area **5** with minimum electromagnetic damping. The 3D part, in this case, is limited by the boundary **6** of material property changes. After the area **5** with minimum electromagnetic damping in the direction of EMG wave propagation, which is limited by the incidence plane **3** and the boundary **6** of material property changes, there follows another area **20** exhibiting a different resonance frequency of the 2D-3D resonator. After the last area **20** exhibiting a different resonance frequency of the 2D-3D resonator, either the free space or a solar system is coupled to the area **11**.

The actual 2D-3D resonator **4** is described in Figs. 4, 6a and 6b. This version of the 2D-3D resonator **4** consists of a transformational component **8** and a reflector **7**, between which the dielectric **10** (such as an insulant) is arranged, with the transformational component **8** constituted by a pair of electrodes in the form of mutually arranged, coupled conductors surrounded by the dielectric **10**. Furthermore, the transformational component **8** is arranged on the dielectric **10**, upon which the reflector **7** is placed orthogonally. Fig. 5 shows the arrangement of the dielectric **10** in the layered structure. The 2D-3D resonator **4** produces electric current or voltage, which is conducted by the help of a nonlinear component **15** to the connecting ~~element~~component **16**; this situation can be seen in Figs. 7a and 7b, where both types of the nonlinear component **15** polarization are described.

Fig. 8 represents an electrical alternate diagram of the solar element. The variants concerned are principially a one-way or two-way rectifier, a shaper, or a signal filter. These types of connection are widely known. A source **19** of alternating current or

voltages caused by the induction from an electromagnetic wave is connected parallelly to the first capacitor **18** and the inductor **14**, which in the connection are constituted by a condenser and a coil. These components then create a tuned alternating circuit, which is tuned to the characteristics and parameters of the incident electromagnetic wave and which resonates. The nonlinear ~~element~~component **15** shapes the signal on the resonant circuit; this signal is then filtered (rectified) to a further utilizable shape. As the next step, connection to the second capacitor **17** is realized; in the connection, the capacitor is constituted by a condenser. Also, in the connection, the connecting components **16** are indicated. These components **16** exhibit electric voltage +U, -U. If a selected electrical load **13** in the form of impedance *Z* is connected to the connecting components **16** (such as clamps), a variation in the resonant circuit occurs and the resonator may change its characteristics to such an extent that it will not be in a suitable resonance mode. Therefore, a device **12** is introduced before the electrical load **13**. With any loading by electrical impedance *Z* on its output, this device will cause the situation when, on the output, the resonator with the nonlinear component **15** and the second capacitor **17** is loaded by one and the same value of impedance *Z*l, which will not change the set mode of the resonator.

The function (or operation) of the solar element, which includes a 2D-3D resonator **4** arranged on a layered dielectric structure, is as follows: An electromagnetic wave **1** within the wavelength range of 100 nm to 100000 nm impinges at the wave incidence point **2** on the incidence plane **3** of the area **5** with minimum electromagnetic damping. The 2D-3D resonator **4** is periodically repeated also in individual areas **20** having different resonance frequencies (as described in Fig. 1 and Fig. 2). In the incidence plane **3** of area **5**, the formation of at least one 2D-3D resonator **4** is arranged. This resonator may operate (perform its function) individually; alternatively, we can realize an interconnection between the resonators, thus creating a field of periodically repeating solar elements. In the incidence plane **3**, these elements are connected parallelly or in series, with the formation of at least two 2D-3D resonators **4** on one solar element appearing to be an advantageous solution. These resonators are interconnected by means of a connecting ~~element~~component **9**. The first area **5** with mimimum electromagnetic damping in the direction of the electromagnetic wave incidence is tuned to the resonance frequency $f_1$ from the domain of the incident electromagnetic wave spectrum; after this area, another area

**20** having a different resonance frequency $f_2$ is included in the direction of the progressing electromagnetic wave. Thus, the progress occurs of other *N* up to the order of hundreds or thousands of areas **20** exhibiting different resonance frequencies, and a system is created; also, there holds that the resonance frequencies of $f_1$ to $f_n$ do not have to be repeated in the layers, and this rule ensures the maximum exploitation of energy of the incident electromagnetic wave.

An electromagnetic wave **1** impinges at the point of incidence **2** on the incidence plane **3**. Here, the electric and magnetic components of the electromagnetic wave **1** decompose and form the maxima of intensities of the electric and magnetic fields. This process is realized thanks to the designed shape of the reflector **7**, which can be a thin layer, a cuboid, a pyramid, a cone, a toroid, or a sphere of their combination, parts, penetration. The surface of the reflector **7** may be formed by a layer of a dielectric material, metal, or a combination and shape variety of both (the components being part of the 2D-3D resonator **4**). In order for the above-mentioned maxima of intensities to add up arithmetically (superpone) when a connection is realized of two periodically repeated 2D-3D resonators **4**, these resonators are connected via a connecting ~~element~~component **9** (as described in Fig. 2). This figure shows an example of the proposed solar element having a 2D-3D resonator arranged in a dielectric structure, where two 2D-3D resonators **4** are arranged at the location of the incidence plane **3**. These resonators are periodically repeated on other dielectric structures **5**; also, the 2D-3D resonators **4** are interconnected by means of the connecting components **9**.

An exemplary embodiment of a solar element including a 2D-3D resonator **4** and arranged in a dielectric is described in Fig. 3. This version of the 2D-3D resonator **4** is arranged in a layered dielectric structure. The area **5** with minimum electromagnetic damping is limited by the boundaries **6** of the material property changes. Mutual arrangement (configuration) of individual parts of the solar element is shown in Fig. 4. The 2D-3D resonator **4** consists of a transformational component **8** (which is composed of a pair of electrodes in the form of coupled conductors), reflector **7**, and a dielectric **10**. The 2D-3D resonator **4** is further embedded in the layered dielectric structure; the geometry is designed in relation to the wavelength of the incident electromagnetic wave, namely in such a manner that the thickness of the dielectric structure will be minimally ¼ of the wavelength of the lowest frequency of

the incident electromagnetic radiation. The proposed geometry design will ensure the resulting resonance characteristic.

After impinging on the incidence plane **3**, the electromagnetic wave permeates through the layered dielectric structure. On the surface of the structure, at the location of the incidence plane **3**, the 2D part of the resonator **4** is arranged, whereas the 3D part occupies a portion of the area **5** having mimimum electromagnetic damping (as illustrated in Figs. 3 or 4). The area **5** with mimimum electromagnetic damping is instrumental towards setting the conditions of the maxima of electrical and magnetic components in the electromagnetic wave incidence plane **3.** In this respect, the layered dielectric structure is designed in such a manner that the progressing electromagnetic wave on the layered dielectric structure could couple and create a resonant area with the maximum resonance on the incidence plane **3**. The area **5** with minimum electromagnetic damping is equipped with a relative electrode **21**. The electromagnetic wave further progresses behind the area **5** with minimum electromagnetic damping; the wave progresses in such a manner that it creates only a minimal reflected wave. The dimensions of the area **5** with minimum electromagnetic damping are selected to be, in the least, equal to or greater than one quarter of the wavelength of the incident electromagnetic wave in relation to the relative permittivity of dielectric **1** (for example, both layers may show the thickness of 10 µm for the selected type of material).

Through achieving the resonant state, there occurs - in at least one solar element within the group of periodically repeating elements that are ordered one after another in the direction of the incident electromagnetic wave - a multiple increase of amplitudes of the original incident electromagnetic wave; for the assumed wavelength of the electromagnetic wave **1** impinging on the incidence plane **3** of the dielectric structure **5**, we can obtain an electric voltage applicable for further processing by electronic circuits **12** that manage the performance and mode of the periodic/layered structure designed for energy harvesting (energy exploitation, “power management“).

A high-quality conductor or dielectric is applied as the material of conductive paths formed in the incidence plane **3**, on which the 2D part of the resonator **4** is arranged; the same high-quality conductor is also used for the transformational ~~element~~component **8**, the connecting ~~element~~component **9** material, and the nonlinear ~~element~~component **15** material. The conductor exhibits different relative

## PATENT CLAIMS

1. A solar element including a resonator arranged on a structure, **characterized in that** it is formed by a layered dielectric structure consisting of an area **(5)** with minimum electromagnetic damping, whose upper plane constitutes the incidence plane **(3)**, and the layered dielectric structure is permeable for an electromagnetic wave and limited by the boundaries **(6)** of variations in material properties, while at least one 2D-3D resonator **(4)** is arranged in the area **(5)** with minimum electromagnetic damping, wherein the 2D part of the resonator is arranged in the incidence plane **(3),** with the related 3D part located in the dielectric (**10**) whereas the area **(5)** with minimum electromagnetic damping is coupled with at least one area **(20)** having a different resonance frequency, the area (**20**) is limited by the boundaries **(6)** of variations in material properties, and at least one 2D-3D resonator **(4)** is arranged in the area **(20)** having a different resonance frequency, wherein the 2D part of the resonator (**4**) is arranged in the incidence plane **(3)**, while the related 3D part is located in the dielectric **(10**), whereas the last area **(20)** having a different resonance frequency in the direction of the electromagnetic wave propagation is coupled with a solar system (**11**).

2. The solar element including a resonator according to claim 1, **characterized in that** the 2D-3D resonator (**4**) is formed by two parts, of which the first 2D part is constituted by a transformational ~~element~~component (**8**) arranged on the incidence plane (**3**) and consisting of a pair of electrodes in the form of coupled conductors, while the second 3D part is constituted by a dielectric (**10**) and a reflector (**7**), which is arranged inside the area (**5**) with minimum electromagnetic damping, and the transformational component (**8**) is arranged on the dielectric (**10**), with which the reflector (**7**) is matched.

3. The solar element including a resonator according to claim 2, **characterized in that** the 2D-3D resonator (**4**) is formed by two parts, of which the first 2D part is constituted by a transformational ~~element~~component (**8**) arranged on the incidence plane (**3**) and consisting of a pair of electrodes in the form of coupled conductors, while the second 3D part is constituted by a dielectric (**10**) and a reflector (**7**), which

is arranged inside the area (**20**) with a different resonance frequency, and the transformational component (**8**) is arranged on the dielectric (**10**), with which the reflector (**7**) is matched.

4. The solar element including a resonator according to claims 2 and 3, **characterized in that** the reflector (**7**) is, in relation to the dielectric (**10**), arranged orthogonally to the incidence plane **(3)**.

5. The solar element including a resonator according to claims 1 to 4, **characterized in that** the area **(5)** with minimum electromagnetic damping may comprise a 2D-3D resonator (4) exhibiting a resonance frequency consistent with frequency of 2D-3D resonators (4) arranged in other areas **(20)** with different resonance frequency within the solar system.