Claims

1. Device (10, 40, 60, 105, 150) for generating electromagnetic THz radiation with free electron beams (54, 56, 78, 190, 192), comprising an oscillator (26, 47, 66,196) supplying an alternating oscillator voltage with a frequency from 0.1 THz to 10 THz, which corresponds to a wavelength of 300 µm to 3 µm and a dynatron tube (22, 99, 130, 180), where the dynatron tube (22, 99, 130) comprises an electron source (12, 58, 72, 76, 96, 124,), an extraction grid (14, 44, 68, 64, 82), an anode (16, 46, 70, 84, 102) preferably coated with a material composition for high secondary electron emission, where the dynatron tube (22, 99, 130, 180) is arranged in vacuum, furthermore the device comprises a voltage supply, where the dynatron tube (22, 99, 130, 180) is connected to the voltage supply (24, 52) supplying an extractor voltage between electron source (12, 58, 72, 76, 96, 124) and extraction grid (14, 44, 68, 64, 82), and the device furthermore comprises a voltage divider to extract a work point voltage from the voltage divider, which is combined with the oscillator voltage to an anode voltage, which is defined as potential difference between electron source (12, 58, 72, 76, 96, 124) and anode (16, 46, 70, 84, 102), with the setting that the anode voltage is lower than the extractor voltage , furthermore the voltage divider is embodied in a way that the work point voltage is set to a voltage where an anode current becomes zero, furthermore the extraction grid (14, 44, 68, 64, 82) and the anode (16, 46, 70, 84, 102) of the dynatron tube (22, 99, 130, 180) are positioned in a distance smaller than half of the wavelength of the electromagnetic radiation to be emitted, where the oscillator voltage accelerates a positive primary free electron beam from the electron source to the anode (16, 46, 70, 84, 102) in the first half of the voltage swing of the oscillator voltage, and in the second half of the voltage swing of the oscillator voltage such a primary free electron beam is accelerated that it generates a secondary free electron beam at the anode that is emitted from the anode (16, 46, 70, 84, 102) to the extraction grid (14, 44, 68, 64, 82, 186, 188), which has twice the number of electrons of the primary free electron beam and therefore a charge flow in reverse direction to

the primary electron beam results, and therefore the alternating oscillator voltage leads to free electron beams flying in alternating directions, which emit an electromagnetic radiation with a frequency from 0.1 THz to 10 THz, **characterized in** that the device furthermore comprises two triode structures, where the dynatron tube (22, 99, 130, 180) is connected to both triode structures (182, 184) where the triode structures (182, 184) are connected to the oscillator in a way that an triode extractor voltage is fed to extraction grids (186, 188), of the triode structures (182, 184), where the extraction voltage matches the oscillator voltage, therefore electrons are emitted as free triode electron beam (190) from the first triode structure (182) in a first half-wave of the oscillator voltage supplied by the oscillator (196) of the dynatron, where the second triode structure (184) is connected to the oscillator (26, 47, 66, 194, 196) via a capacitor (194), which reverses the oscillator voltage controlling the emission of the second triode and due to the capacitor (194) a free triode electron beam is emitted by the second triode structure (182, 184) in the negative voltage drop of the second half wave of the oscillator voltage used as the extraction voltage in the second triode structure (184), furthermore the device comprises a resonator (204,206) which is positioned between the extraction grids of the triode structures (182, 184) and the resonator (204,206) comprises at least one hole that allows traveling of the free triode electron beams through the resonator (204, 208), where the resonator (204, 206) is embodied as anode of the triode, where the anode voltage is higher than the triode extractor voltage.

2. Device according to claim 1, **characterized in** that, the triode structures (182, 184) are placed in opposite to each other and send electron beams in opposite to each other.

~~3. Device (10, 40, 60, 105, 150) for generating electromagnetic THz radiation with free electron beams (54, 56, 78, 190, 192), comprising an oscillator (26, 47, 66, 194, 196) supplying an alternating oscillator voltage with a frequency from 0.1 THz to 10 THz, which corresponds to a wavelength of 300 µm to 3 µm, and a dynatron tube (22, 99, 130, 180), where the dynatron tube (22, 99, 130, 180) comprises an electron source (12, 58, 72, 76, 96, 124), an extraction grid (14, 44, 68, 64, 82), an anode (16, 46, 70, 84, 102) preferably coated with a material composition for high secondary electron emission, where the dynatron tube (22, 99, 130, 180) is arranged in vacuum, furthermore the device comprises a voltage supply, where the dynatron tube (22, 99, 130, 180) is connected to the voltage supply (24, 52) supplying an extractor voltage between electron source (12, 58, 72, 76, 96, 124) and extraction grid ((14, 44, 68, 64, 82)), and the device furthermore comprises a voltage divider to extract a work point~~

~~voltage from the voltage divider, which is combined with the oscillator voltage to an anode voltage, which is defined as potential difference between electron source (12, 58, 72, 76, 96, 124) and anode (16, 46, 70, 84, 102), with the setting that the anode voltage is lower than the extractor voltage , furthermore the voltage divider is embodied in way that the work point voltage is set to a voltage where an anode current becomes zero, **characterized in that** the extraction grid (14, 44, 68, 64, 82) and the anode (16, 46, 70, 84, 102) of the dynatron tube (22, 99, 130, 180) are positioned in a distance smaller than half of the wavelength of the electromagnetic radiation to emit, where the oscillator voltage accelerates a positive primary free electron beam from the electron source (12, 58, 72, 76, 96, 124) to the anode (16, 46, 70, 84, 102) in the first half of the voltage swing of the oscillator voltage, and in the second half of the voltage swing of the oscillator voltage such a primary free electron beam is accelerated that it generates a secondary free electron beam at the anode (16, 46, 70, 84, 102) that is emitted from the anode (16, 46, 70, 84, 102) to the extraction grid (14, 44, 68, 64, 82), which has twice the number of electrons of the primary free electron beam and therefore a charge flow in reverse direction to the primary electron beam, results and therefore the alternating oscillator voltage leads to free electron beams in alternating directions, which emit an electromagnetic radiation with a frequency from 0.1 THz to 10 THz.~~

~~4.~~3. Device according to any one of the preceding claims, **characterized in** that the device is fabricated in a miniaturized way, where at least the dynatron tube (22, 99, 130, 180) and the oscillator (26, 47, 66, 194, 196) are fabricated as micro- or nanostructures.

~~5.~~4. Device according to any one of the preceding claims, **characterized in** that the oscillator (26) is formed as a tuneable complex resistor comprising a resistor, an inductivity (18, 48) and a capacitor (20, 50), with the capacitor (20, 50) and / or the inductivity (18, 48) being tuneable.

~~6.~~5. Device according to claim 2 ~~or 3~~ **characterized in** that the Dynatron tube (22, 99, 130, 180) is embodied as a microstructure integrated on an insulator (88, 122, 140, 153) with heated or cold electron source (12, 58, 72, 76, 96, 124, 200, 202).

~~7.~~6. Device according to any one of the preceding claims, **characterized in** that the electron source is a cold field emission emitter in form of a wire with a tip (76) of less than 1 µm tip radius.

~~8.~~7. Device according to claim ~~7~~6, **characterized in** that the electron source is fabricated as micro- or nanostructure field emitter, where a material is deposited on the tip of the field emitter, having a low work function and emits electrons at least in response to the extraction voltage.

~~9.~~8. Device according to any one of the preceding claims, **characterized in** that the electron source is fabricated as micro- or nanostructure and is constructed in form of a cold field electron edge emitter (124) from metal, or metal oxide, or carbon, or carbon compound, or other semiconductor material, or nano-granular compound material.

~~10.~~9. Device according to any one of the preceding claims, **characterized in** that the device comprises a controllable voltage source connected via at least one electrical terminal and connection to the electron source that is fabricated as micro- or nanostructured field emitter , to stabilize radiation from the electron source(12, 58, 72, 76, 96, 124, 200, 202) wherein the electron beam is emitted from at least one tip of the field emitter and is then collected on the anode.

~~11.~~10. Device according to any one of the preceding claims, **characterized in that** the device comprises an at least electrically conducting housing having at least one radiation transmissive and vacuum tight lens and the dynatron tube (99, 130) that is fabricated as micro- or nanostructure, and an oscillator (86, 136), which are surrounded by the conducting housing (80, 134) in the rectangular form of a THz electromagnetic wave confining a cavity resonator, where the dimensions of the conducting housing are adapted to frequency and wavelength of emitted radiation.

~~12.~~11. Device according to any one of the preceding claims, **characterized in that** it comprises an at least electrically conducting housing having at least one radiation transmissive and vacuum tight lens (74, 99, 98,104,128), two Dynatron tube structures (99, 130) that are fabricated as micro- or nanostructure and oscillators which are built on top and on the bottom of an insulating base, which is centrally arranged in the conducting housing, having an open hole between the extraction grid and the anode.

~~13.~~12. Device according to any one of the preceding claims, **characterized in** that it comprises a pumping cell (92), which comprises a pumping device (108) that provides vacuum, where the pumping cell (92) is at least connected to the dynatron tube (22, 99, 130, 180) and particularly

to a cavity resonator (94), where it is connected to its volume though a grid or mesh structure (106),e which reflects the electromagnetic radiation, but transmits the gas from at least the dynatron tube (22, 99, 130, 180) to the pumping cell (92).

~~14.~~13. Device according to any one of the preceding claims, **characterized in** that it comprises a pumping device, embodied as conventional high vacuum pumping system, and / or an miniaturized vacuum pump that is producing high vacuum, especially as miniaturized Orbitron pump and / or deposited getter materials (108).

~~15.~~14. Device according to any one of the preceding claims, **characterized in** that it is constructed as a THz Emitter Cell (105) with THz-radiation emitted out of the both sides of the THz Emitter Cell (105) and is using THz radiation mirrors (112) inclined in respective to the direction of the emitted radiation e.g. in form of fine metal mesh areas to direct the radiation in a parallel direction, and uses at least one THz radiation focusing lens (114) to supply the radiation in a focused manner to an object.

~~16.~~15. Device according to any one of the preceding claims, **characterized in** that the device comprises a resonator with at least four walls, where emitted wavelength is tuneable, and where at least one wall (156) and at least one anode (158) is moveable to tune the device, where the anode is positioned in a static distance to the corresponding wall.

~~17.~~16. Device according to claim ~~5 and 14~~4 or 15, **characterized in** that tuneability is realized by the tuneable capacitor of the oscillator circuit, and due to the position of resonator walls and of the anode, where anode and at least one moveable resonator wall is connected to mechanical means like NiTiNOL-stages, that use currents in the NiTiNOL wires or Piezo-effect driven micro actuators to change the capacity of the oscillator, to move the moveable resonator wall and the anode to define and to select the wavelength of the THz radiation to be emitted.

~~18.~~17. Usage of a device as defined in claim 1 for generating electromagnetic radiation at THz frequency.