Claims

1. A cardiac pacemaker (100), characterized in that the cardiac pacemaker (100) comprises a multiple of microneedles (10) forming an array of microneedles (10);
   a chip (20) comprising at least one comparator with adaptive level, a sequence control circuit, at least one capacitor stack built by n capacitors and 2n switches, at least one buffer capacitor outside the at least one capacitor stack, at least two additional switches outside the at least one capacitor stack and a CMOS-Logic, wherein $n \in N$;
   an interposer layer (30) comprising holes (31) for the multiple of microneedles (10);
   a lid (40);
   at least one coil (800);
   wherein the chip (20), is located on one surface of the interposer layer (30);
   wherein the lid (40) and the interposer layer (30) form a capsule for the chip (20) and the at least one coil (800);
   wherein each microneedle (10) has a distal end which protrudes from the chip (20); and
   wherein the cardiac pacemaker (100) is adapted to be electrically self-sufficient due to harvesting of electrical energy from myocardial cells.

2. A cardiac pacemaker (100) according to claim 1, characterized in that the cardiac pacemaker (100) further comprises at least one sensor (50) and/or at least one further capacitor (60).

3. A cardiac pacemaker (100) according to claim 2, characterized in that the sensor (50) is implemented as a micromechanical (MEMS) activity sensor, an electrostatical accelerometer or a piezoceramic accelerometer.

4. A cardiac pacemaker (100) according to any of the preceding claims, characterized in that the cardiac pacemaker (100) comprises between 5 and 10000 microneedles (10), preferably between 25 and 1000 microneedles (10), most preferably between 100 and 250 microneedles (10).

5. A cardiac pacemaker (100) according to any of the preceding claims, characterized in that the cardiac pacemaker (100) further comprises an external programmer unit (900a, 900b).

6. A cardiac pacemaker (100) according to any of the preceding claims, characterized in that every microneedle (10) is adapted to be operable independent of the other microneedles (10).

7. A cardiac pacemaker (100) according to any of the preceding claims, characterized in that the cardiac pacemaker (100) is between 1 mm and 8 cm long, between 1 mm and 5 mm wide and between 3 mm and 10 mm high.

8. A cardiac pacemaker (100) according to any of the preceding claims, characterized in that the diameters of the distal ends (14) of the multiple of microneedles are between 0.001 mm and 0.1 mm, preferably between 0.01 mm and 0.1 mm, most preferably the diameters of the distal ends (14) of the multiple of microneedles are 0.02 mm.

9. A cardiac pacemaker (100) according to any of the preceding claims, characterized in that the microneedles (10) comprise a material of the group comprising Platin/Iridium (PtIr), gold, and fine metals.

10. A cardiac pacemaker (100) according any of the preceding claims, characterized in that each microneedle (10) is adapted to be able to harvest cellular energy, to electrically stimulate live tissue and to sense intrinsic cellular electrical activity.

11. A cardiac pacemaker (100) according to any of the preceding claims, characterized in that the interposer layer (30) further comprises at least two fixation holes (70, 71) outside the lid (40).

~~12. Method for stimulating myocardial tissue utilizing a cardiac pacemaker (100) according to any of claims 1 to 11, characterized in that~~

- ~~the microneedles (10) of the array of microneedles (10) are inserted into myocardial tissue;~~
- ~~a cardiac cycle time is set;~~
- ~~optionally a minimum cardiac cycle time is set;~~
- ~~at least one reference level for the cellular electrical activity is set;~~
- ~~at least one microneedle (10) of the array of microneedles (10) is set to emit an electrical pulse;~~

- at least one microneedle (10) of the array of microneedles (10) is set to sense the amplitude of the cellular electrical activity and to harvest energy;
- the amplitude of the cellular electrical activity is sensed and energy is harvested at least by one microneedle (10);
- the cardiac cycle time starts if the amplitude of the cellular electrical activity sensed by at least one microneedle (10) of the array of microneedles reaches the reference level of the corresponding microneedle (10) of the array of microneedles or after a pulse is emitted into the myocardial tissue by at least one microneedle (10) of the array of microneedles; and
- an electrical pulse is applied to the myocardial tissue by at least one microneedle (10) of the array of microneedles if no cellular electrical activity with an amplitude above the reference level is sensed anymore during the cardiac cycle time after the amplitude of the sensed cellular electrical activity has been fallen below the reference level;

wherein the electrical pulse is generated utilizing the harvested energy.

13. Method according to claim 12, characterized in that an electrical pulse is applied to the myocardial tissue by the microneedle (10) having the lowest energy demand.

14. Method according to claim 12 or claim 13, characterized in that the electrical pulse is a monophasic pulse or a bipolar pulse.

15. Method according to any of claims 12 to 14, characterized in that the harvested energy is collected into the at least one buffer capacitor or a buffer capacitor array.

16. Method according to any of claims 12 to 15, characterized in that motions of the biological tissue are sensed by the sensor (50) and that the cardiac cycle length is set to the minimum cardiac cycle length if motions of the biological tissue are sensed.