CLAIMS

1. A THz photomixer emitter comprising:

a photoconductive material; and

a nano-scale antenna structure~~; and~~, the nano-scale antenna structure comprising a dipole antenna structure having opposing main electrodes for opposite biasing and an electrode array disposed between and connected to the opposing main electrodes for enhancing both ~~such that~~ an electric field associated with photocarriers generated in the photoconductive material ~~is coupled to the nano-scale antenna structure for~~ and emission of a THz wave via the nano-scale antenna structure~~;~~, and wherein the electrode array comprises two sets of electrode elements, each electrode element comprising a trunk portion connected to a respective one of the main electrodes and a set of branch portions extending from the trunk portion, wherein at least a portion of a first set of branch portions are disposed in a tip-to-tip configuration with corresponding ones of a similar at least a portion of a second set of branch portions such that an electric field resonance direction between opposing ones of the at least a portion of the first and second set of branches of the respective sets of the electrode elements is the same as a favored electric field direction of the dipole antenna structure for substantially ~~aligned~~ aligning an electric field resonance direction with an emission field pattern of the nano-scale antenna structure.

~~2. The emitter as claimed in claim 1, wherein the nano-scale antenna structure comprises a dipole antenna structure having opposing main electrodes for opposite biasing, and the electrode array is disposed between the main electrodes.~~

2~~3~~. The emitter as claimed in claim 1 ~~or claim 2~~, wherein the at least a portion of the ~~electrode array~~ first and second sets of branches of the electrode elements comprises ~~s~~ two sets of finger electrodes disposed in ~~a~~ the tip-to-tip configuration, each set electrically connected to a respective ~~on~~one of the main electrodes, and such that an electric field resonance direction between opposing fingers of the respective sets is the same as ~~a~~ the favored electric field direction of the dipole antenna structure.

3~~4~~. The emitter as claimed in claim 2~~3~~, wherein the tips of the respective finger electrodes are tapered for enhancing the electric field associated with the photocarriers generated in the photoconductive material.

~~5. The emitter as claimed in claim 2, wherein the electrode array comprises two sets of electrode elements, each electrode element comprising a trunk portion connected to a respective one of the main electrodes and branch portions extending from the trunk portion, wherein the branch portions are disposed such that an electric field resonance direction between opposing branches of the respective sets is the same as the favored electric field direction of the dipole antenna structure.~~

4~~6~~. The emitter as claimed in claim 1~~5~~, wherein the ~~at least some of the electrode elements~~ first and second sets branch portions comprise branch portions extending in different directions from the trunk portion.

5~~7~~. The emitter as claimed in claim 1, wherein the electrode array comprises two sets of electrode elements, wherein pairs of opposing electrode elements of the respective sets are configured in a circular electrode design.

6~~8~~. The emitter as claimed in claim 1, wherein the electrode array comprises two sets of electrode elements, wherein pairs of opposing electrode elements of the respective sets are configured in a spiral electrode design.

7~~9~~. The emitter as claimed in claims 5 or 6~~7 or 8~~, wherein the nano-scale antenna structure comprises a broadband antenna.

8~~10~~. The emitter as claimed in claim 7~~9~~, wherein the THz wave is circularly polarized.

9~~11~~. A method for emitting a THz wave, the method comprising the steps of:

providing a photoconductive material;

~~providing~~coupling a nano-scale antenna structure to the photoconductive material, the nano-scale antenna structure being configured to comprise a dipole antenna structure having opposing main electrodes for opposite biasing and the electrode array is disposed between the main electrodes; and

generating photocarriers having an associated electric field in the photoconductive material ~~providing an electrode array disposed~~ such that ~~an~~ the electric field associated with the photocarriers generated in the photoconductive material ~~is coupled to the nano-scale antenna structure for emission of~~ emits the THz wave via an electrode array of the nano-scale antenna structure[[;]], ~~wherein the electrode array is configured such that an electric field resonance pattern of the electrode array is substantially matched to an emission field pattern of the nano-scale antenna structure,~~

wherein the electrode array is configured to comprise two sets of electrode elements, each electrode element comprising a trunk portion connected to a respective one of the main electrodes and sets of branch portions extending from the trunk portion, wherein finger electrodes of at least a portion of a first set of the branch portions are disposed in a tip-to-tip configuration with corresponding finger electrodes of at least a portion of a second set of the branch portions such that an electric field resonance direction between opposing branch portions of the respective sets of electrode elements is the same as a favored electric field direction of the dipole antenna structure for emission of the THz wave~~pattern of the electrode array is substantially matched to an emission field pattern of the nano-scale antenna structure~~.