CLAIMS

1. A sensing system comprising:

a material comprising a matrix and a plurality of non-insulating particles substantially equally spaced within the matrix such that material has coherent electrical periodicity in at least one dimension; and

a receiver arranged to receive a source RF signal for interrogating the material and a returned RF signal, the source RF signal being reflected by the non-insulating particles to produce the returned RF signal;

wherein interrogating the material comprises exciting the material as if it was an antenna to generate a surface field profile; and

wherein a change in the position of one or more of the non-insulating particles causes the returned RF signal to change, such that a change in a property of the material can be determined from the returned RF signal.

2. The system according to claim 1 wherein the matrix is a non-conductive matrix and the non-insulating particles are conducting particles.

3. The system according to claim 2, wherein the conductive particles include at least one of carbon particles, carbon fibre , graphenes, aluminium particles, silver particles, copper particles, gold particles, and carbon nanotubes.

4. The system according to claim 1, wherein the non-insulating particles are semiconducting particles.

5. The system according to claim 1, wherein the non-insulating particles are composite particles comprising a metal and an insulator.

6. The system according to any preceding claim, wherein the insulating matrix comprises a polymer.

7. The system according to claim 6, wherein the insulating matrix comprises at least one of a thermosetting epoxy, thermoplastic polyester, vinyl ester or nylon.

8. The system according to any preceding claim, wherein the material has a coherent periodic conductivity in at least one dimension.

9. The system according to any preceding claim, wherein the material has a coherent periodic dielectric constant in at least one dimension.

10. The system according to any preceding claim, wherein the change in the returned RF signal is any of a change in amplitude, a change in frequency, a phase-shift, or a change in interference effects.

11. The system according to any preceding claim, wherein the change in a property of the material is any of a particle break, a microcrack, a delamination, a contaminant, matrix impact damage, or a change in porosity.

12. The system according to any preceding claim, wherein the receiver is arranged to receive ambient RF signals.

13. A method of sensing a change in a property of a material, the material comprising a matrix and a plurality of non-insulating particles substantially equally spaced within the matrix such that the material has coherent electrical periodicity in at least one dimension, the method comprising the steps of:

interrogating the material with a source RF signal, wherein interrogating the material comprises exciting the material as though it was an antenna to generate a surface field profile;

receiving a returned RF signal reflected from the non-insulating particles; and

determining the change in the property of the material from a change in the returned RF signal that is caused by a change in the position of one or more of the non-insulating particles.

14. The method according to claim 13, wherein interrogating the material comprises scanning the surface of the material using a single mechanical probe.

15. The method according to claim 13, wherein interrogating the material comprises scanning the surface of the material with an electronic multiple probe along a 1D or 2D path.

~~16. The method according to claim 13, wherein interrogating the material comprises exciting the material as though it was an antenna to generate a surface field profile~~.

~~17~~16. The method according to claim ~~16~~13, wherein interrogating the material further comprises scanning the surface field profile using a single mechanical probe.

~~18~~17. The method according to claim ~~16~~13, wherein interrogating the material further comprises scanning the surface field profile using an electronic multiple probe.

~~19~~18. The method of claim ~~16~~13, wherein the probe is a 2D probe array with electronic switching or multiple signal channels.

~~20~~19. The method according to claim ~~19~~18, further comprising placing the 2D probe array in a flexible probe sheet.

~~21~~20. The method according to claims 12 to ~~20~~19, wherein the source RF signal is modulated.

~~22~~21. The method according to claims 12 to ~~21~~20, wherein the material is obtained by doping a semiconductor material to achieve the coherent electrical periodicity.

~~23~~22. The method according to claims 15 to ~~22~~21, wherein the material comprises a plurality of cells and wherein each cell represents an antenna element.

~~24~~23. The method according to claim ~~23~~22, wherein the plurality of cells are coupled and form a cell array.

~~25~~24. The method according to claim ~~24~~23, wherein the plurality of cells coupled via induced modulated RF currents.

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~~26~~25. The method according to claims ~~17~~ to ~~25~~24, wherein the probe array comprises at least one high impedance probe.

~~27~~26. The method according to claim ~~26~~25, wherein the high impedance probe comprises a plurality of metal micro-elements.

~~28~~27. The method according to claim ~~26~~25, wherein the high impedance probe is a diode rectifier or a gate of a field effect transistor.

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~~29~~28. The method according to claims ~~27~~ or ~~28~~27, wherein the returned RF signal is received by a homodyne receiver.

~~30~~29. The method according to claims 12 to ~~29~~28, wherein interrogating the material comprises introducing an electromagnetic field mode within the material and wherein receiving the returned RF signal comprises detecting a surface evanescent electromagnetic field of the material.

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~~31~~30. The method according to claims ~~24~~ to ~~30~~29, wherein the plurality of cells form a wireless cellular network.

~~32~~31. The method or system according to any preceding claim, wherein determining the change in the property of the material comprises 2D or 3D imaging of the composite material.

~~33~~32. The method or system according to any preceding claim, wherein determining the change in the property of the material comprises detecting an anisotropic conductivity of the material.

~~34~~33. The method or system according to any preceding claim, wherein the property of the material is crystallinity.

~~35~~34. The method according to claims 13 to ~~32~~31, comprising a system according to claims 1 to 12.