[0004] Because NITI allows for the non-destructive testing and monitoring of an object or system whenever thermal signals are present, NITI may be utilized in many diverse applications. In cases where sufficient thermal signals are not present, they can be generated at the object or system surface.

SUMMARY

[0004a] In an aspect, the present disclosure refers to a system for non-invasive sensing of an object having a volume with a surface and an internal region, comprising: a non-invasive sensor including: a heat flux sensor having one or more heat flux sensor output terminals; a temperature sensor having one or more temperature sensor output terminals, wherein the non-invasive sensor is adapted to be placed on or near the surface of the object, where the internal region of the object has internal properties indicated by corresponding internal parameter(s) and an internal temperature distribution, circuitry, coupled to the one or more heat flux sensor output terminals and the one or more temperature sensor output terminals, to: receive a measured temperature signal from the temperature sensor at one or more specified times; receive a measured heat flux signal from the heat flux sensor at one or more specified times; determine an estimated indicative quantity for one or more of the internal properties at one or more specified times based on at least the measured temperature signal and the measured heat flux signal; and generate information indicating one or more of the estimated indicative quantit(ies) determined for the internal propert(ies) of the object at one or more specified times.

[0004b] In another aspect, the present disclosure refers to a system for non-invasive sensing of an object having a volume with a surface and an internal region, comprising: a first non-invasive, heat flux sensor-temperature sensor pair; a second non-invasive, heat flux sensor-temperature sensor pair; each of the first and second non-invasive, heat flux sensor-temperature sensor pairs including: a heat flux sensor having one or more heat flux sensor output terminals; a temperature sensor having one or more temperature sensor output terminals, wherein the first and second non-invasive, heat flux sensor-temperature sensor pairs are adapted to be placed at different locations on or near the

surface of the object and are subject to a differential heat flux environment, and where the internal region of the object has internal properties indicated by corresponding internal parameter(s) and an internal temperature distribution, circuitry, coupled to the one or more heat flux sensor output terminals and the one or more temperature sensor output terminals of each of the first and second non-invasive, heat flux sensor-temperature sensor pairs, and configured to: receive a first measured temperature signal from the temperature sensor in the first non-invasive, heat flux sensor-temperature sensor pair at one or more specified times; receive a first measured heat flux signal from the heat flux sensor in the first non-invasive, heat flux sensor-temperature sensor pair at one or more specified times; receive a second measured temperature signal from the temperature sensor in the second non-invasive, heat flux sensor-temperature sensor pair at one or more specified times; receive a second measured heat flux signal from the heat flux sensor in the second non-invasive, heat flux sensor-temperature sensor pair at one or more specified times; determine an estimated indicative quantity for one or more of the internal properties of the object at one or more specified times based on at least the measured temperature signals from the temperature sensors in the first and second non-invasive, heat flux sensor-temperature sensor pairs at one or more specified times and the measured heat flux signals from the heat flux sensors in the first and second non-invasive, heat flux sensor-temperature sensor pairs at one or more specified times; and generate information indicating one or more of the estimated indicative quantit(ies) determined for the internal propert(ies) of the object at one or more specified times.

[0004c] In another aspect, the present disclosure refers to a non-invasive sensor adapted to be placed on or near a surface of an object having a volume with a surface and an internal region, where the internal region of the object has internal properties indicated by corresponding internal parameter(s) and an internal temperature distribution, the non-invasive sensor comprising: a non-invasive, heat flux sensor-temperature sensor pair; the non-invasive, heat flux sensor-temperature sensor pair including: a heat flux sensor having one or more heat flux sensor output terminals to provide a measured heat flux signal for a location on or near the surface of the object, and a temperature sensor having one or more temperature sensor output terminals to provide a measured

temperature signal for a location on or near the surface of the object, wherein the non-invasive sensor is configured to ensure that a mismatch does not exist between the measured heat flux signal and the measured temperature signal.

[0004d] In another aspect, the present disclosure refers to a non-invasive sensor adapted to be placed on or near a surface of an object having a volume with a surface and an internal region, where the internal region of the object has internal properties indicated by corresponding internal parameter(s) and an internal temperature distribution, the non-invasive sensor comprising: a first non-invasive, heat flux sensor-temperature sensor pair; a second non-invasive, heat flux sensor-temperature sensor pair; each of the first and second non-invasive, heat flux sensor-temperature sensor pairs including: a heat flux sensor having one or more heat flux sensor output terminals; a temperature sensor having one or more temperature sensor output terminals, wherein the first and second non-invasive, heat flux sensor-temperature sensor pairs are adapted to be placed at different locations on or near the surface of the object and are subject to a differential heat flux environment.

[0005] At least some examples provide a system for non-invasive sensing of an object having a volume with a surface and an internal region. The system comprises a non-invasive sensor including: a heat flux sensor having one or more heat flux sensor output terminals, and a temperature sensor having one or more temperature sensor output terminals. The non-invasive sensor may be placed on or near the surface of the object. The internal region of the object has internal properties indicated by corresponding internal parameters and an internal temperature distribution. Control circuitry, coupled to the one or more heat flux sensor output terminals and the one or more temperature sensor output terminals, is adapted to: receive a measured temperature signal from the temperature sensor at one or more specified times; receive a measured heat flux signal from the heat flux sensor at the one or more specified times; determine a measure of heat transfer leaving or entering the object at the surface based on the measured heat flux signal at the one or more specified times; determine a value for each of the internal parameters at the one or more specified times; determine an internal temperature

distribution of the internal region of the object at the one or more specified times based on the measured temperature signal, the measured heat flux signal, and the values of the internal parameters; and generate information indicating the internal temperature distribution of the internal region of the object at the one or more specified times.

[0006] At least some examples provide a system for non-invasive sensing of an object having a volume with a surface and an internal region. The system includes a non-invasive sensor including: a heat flux sensor having one or more heat flux sensor output terminals, and a temperature sensor having one or more temperature sensor output terminals. The non-invasive sensor is adapted to be placed on or near the surface of the object, and the internal region of the object has internal properties indicated by corresponding internal parameters and an internal temperature distribution. Control

Claims

1. A system for non-invasive sensing of an object having a volume with a surface and an internal region, comprising:

a non-invasive sensor including:

a heat flux sensor having one or more heat flux sensor output terminals;

a temperature sensor having one or more temperature sensor output terminals,

wherein the non-invasive sensor is adapted to be placed on or near the surface of the object, where the internal region of the object has internal properties indicated by corresponding internal parameter(s) and an internal temperature distribution,

circuitry, coupled to the one or more heat flux sensor output terminals and the one or more temperature sensor output terminals, to:

receive a measured temperature signal from the temperature sensor at one or more specified times;

receive a measured heat flux signal from the heat flux sensor at one or more specified times;

determine an indicative quantity for one or more of the internal parameters at one or more specified times;

determine an internal temperature distribution of the internal region of the object at one or more specified times based on at least the measured temperature signal, the measured heat flux signal, and the indicative quantit(ies) determined for the internal parameter(s); and

generate information indicating the internal temperature distribution of the internal region of the object at one or more specified times.

2. The system of claim 1, wherein the circuitry is configured to determine a measure of heat transfer leaving or entering the object at the surface based on the measured heat flux signal.

3. The system of claim 1, wherein the circuitry is configured to generate information indicating one or more of the indicative quantit(ies) determined for the internal parameter(s) at one or more specified times.

4. The system of claim 1, wherein the circuitry is configured to include one or more effects associated with an estimated thermal contact resistance between the temperature sensor and the surface of the object.

5. The system of claim 1, wherein the circuitry is configured to generate the generated information indicating the internal temperature distribution of the internal region of the object at a specified time in less than one second from that specified time.

6. The system of claim 3, wherein the circuitry is configured to generate the generated information indicating one or more of the indicative quantit(ies) determined for the internal parameter(s) at a specified time in less than one second from that specified time.

7. The system of claim 1, wherein the circuitry is configured to use a predetermined indicative quantity for one or more of the internal parameters at specified time(s).

8. The system of claim 1, wherein the circuitry is configured to use an estimated indicative quantity for one or more of the internal parameters at specified time(s).

9. The system of claim 1, wherein the circuitry is configured to:

determine an estimated indicative quantity for one or more of the internal parameters at one or more specified times based on at least the measured temperature signal, the measured heat flux signal, and one or more effects associated with an estimated thermal contact resistance between the temperature sensor and the surface of the object.

10. The system of claim 9, wherein the circuitry is configured to:

determine a calculated sensor temperature at one or more specified times based on at least the measured temperature signal, the measured heat flux signal, one or more of the estimated internal parameter indicative quantit(ies), one or more remaining internal parameter indicative quantit(ies) when there are one or more remaining internal parameter indicative quantit(ies), and one or more effects associated with the estimated thermal contact resistance; and

compare the calculated sensor temperature with a measured temperature that is based on the measured temperature signal to determine a difference.

11. The system of claim 10, wherein the circuitry is configured to:

adjust one or more of the estimated indicative quantit(ies) for the internal parameter(s) and the estimated thermal contact resistance based on the

difference to produce updated estimated indicative quantit(ies) for the internal parameter(s) and the estimated thermal contact resistance; and

determine the internal temperature distribution of the internal region of the object based on at least the measured temperature signal, the measured heat flux signal, and the updated estimated indicative quantit(ies) for the internal parameter(s) and the estimated thermal contact resistance.

12. The system of claim 10, wherein the circuitry is configured to adjust one or more of the estimated indicative quantit(ies) for the internal parameter(s) and the estimated thermal contact resistance to reduce the difference, and

wherein when the difference is less than a threshold amount or otherwise determined to be minimal, the estimated indicative quantit(ies) for the internal parameter(s) and the estimated thermal contact resistance are optimally updated and the circuitry is configured to generate information indicating the optimally updated estimated indicative quantit(ies) for the internal parameter(s) and the estimated thermal contact resistance.

13. The system of claim 10, wherein the circuitry is configured to adjust one or more of the estimated indicative quantit(ies) for the internal parameter(s) and the estimated thermal contact resistance using one or more optimization techniques.

14. The system of claim 10, wherein the circuitry is configured to adjust one or more of the estimated indicative quantit(ies) for the internal parameter(s) and the estimated thermal contact resistance using one or more machine learning techniques.

15. The system of claim 9, wherein the circuitry is configured to determine the estimated thermal contact resistance independent of the internal parameter(s).

16. The system of claim 9, wherein the circuitry is configured to determine the estimated thermal contact resistance based on the internal parameter(s).

17. The system of claim 9, wherein the circuitry is configured to determine the estimated thermal contact resistance based on a total steady-state thermal resistance of the object.

18. The system of claim 10, wherein the circuitry is configured to adjust one or more of the estimated indicative quantit(ies) for the internal parameter(s) and the estimated thermal contact resistance in real-time.

19. The system of claim 1, wherein the circuitry is configured to determine the internal temperature distribution of the internal region of the object using one or more machine learning techniques.

20. The system of claim 1, wherein the circuitry is configured to determine the internal temperature distribution of the internal region of the object using one or more thermal mathematical models for the object.

21. The system of claim 20, wherein the one or more thermal mathematical models has a transient temperature solution defined as a function of initial temperature distribution, heat flux, time, space, and the internal parameter(s).

22. The system of claim 20, wherein the one or more thermal mathematical models includes one or more steady-state conditions.

23. The system of claim 21, wherein the initial temperature distribution is based on a steady-state temperature profile.

24. The system of claim 1, wherein the internal parameters include one or more from a list comprising:

R'': steady-state thermal resistance,

x: depth from the surface,

$R"_{total}$: total steady-state thermal resistance,

U: overall heat transfer coefficient,

k: thermal conductivity,

ρ: density,

C: heat capacity,

ρC: volumetric heat capacity,

$\sqrt{k\rho C}$: thermal inertia,

$\alpha = \frac{k}{\rho C}$: thermal diffusivity,

h: convection heat transfer coefficient,

$\dot{v}$: flowrate,

δ: wall thickness,

τ: time constant, and

w: blood perfusion.

25. The system of claim 1, wherein the non-invasive sensor includes thermal insulation to reduce measured signal noise.

26. The system of claim 1, wherein the non-invasive sensor includes thermal insulation to control an amount of heat transfer occurring through the non-invasive sensor.

27. The system of claim 1, wherein the temperature sensor is a thin-film

~~thermocouple, a thin temperature sensor, a resistance temperature sensor, or a fiber optic temperature sensor.~~

~~28. The system of claim 1, wherein the heat flux sensor is based on differential thermopile technology.~~

~~29. The system of claim 1, wherein the heat flux sensor is based on thin-film technology.~~

~~30. The system of claim 1, wherein the heat flux sensor is a thin heat flux sensor.~~

~~31. The system of claim 1, wherein the heat flux sensor is a flexible heat flux sensor.~~

~~32. The system of claim 1, wherein the heat flux sensor is based on one or more thermoelectric devices.~~

~~33. The system of claim 1, further comprising one or more external thermal devices for heating and/or cooling the non-invasive sensor.~~

~~34. The system of claim 1, wherein the circuitry controls one or more external thermal devices for heating and/or cooling the non-invasive sensor.~~

~~35. The system of claim 1, wherein the circuitry controls one or more external thermal devices for heating and/or cooling the non-invasive sensor towards a measured heat flux signal and/or a measured temperature signal.~~

~~36. The system of claim 1, wherein the temperature sensor is located on or near a heat flux sensor sensing area.~~

~~37. The system of claim 1, wherein the temperature sensor is between the object and heat flux sensor.~~

~~38. The system of claim 1, wherein the heat flux sensor is between the object and temperature sensor.~~

~~39.~~1. A system for non-invasive sensing of an object having a volume with a surface and an internal region, comprising:

a non-invasive sensor including:

a heat flux sensor having one or more heat flux sensor output terminals;

a temperature sensor having one or more temperature sensor output terminals,

wherein the non-invasive sensor is adapted to be placed on or near the surface of the object, where the internal region of the object has internal properties indicated by corresponding internal parameter(s) and an internal temperature distribution,

circuitry, coupled to the one or more heat flux sensor output terminals and the one or more temperature sensor output terminals, to:

receive a measured temperature signal from the temperature sensor at one or more specified times;

receive a measured heat flux signal from the heat flux sensor at one or more specified times;

determine an estimated indicative quantity for one or more of the internal ~~parameters~~ properties at one or more specified times based on at least the measured temperature signal and the measured heat flux signal; and

generate information indicating one or more of the estimated indicative quantit(ies) determined for the internal ~~parameter(s)~~propert(ies) of the object at one or more specified times.

~~40. The system of claim 39, wherein the circuitry is configured to determine a measure of heat transfer leaving or entering the object at the surface based on the measured heat flux signal.~~

~~41. The system of claim 39, wherein the circuitry is configured to include one or more effects associated with an estimated thermal contact resistance between the temperature sensor and the surface of the object.~~

~~42. The system of claim 39, wherein the circuitry is configured to:~~

~~determine one or more of the estimated indicative quantit(ies) for the internal parameter(s) at one or more specified times based on at least the measured temperature signal, the measured heat flux signal, indicative quantit(ies) determined for one or more of the internal properties, and one or more effects associated with an estimated thermal contact resistance between the temperature sensor and the surface of the object.~~

~~43. The system of claim 39, wherein the circuitry is configured to generate the generated information indicating one or more of the estimated indicative quantit(ies) determined for the internal parameter(s) at a specified time in less than one second from that specified time.~~

~~44. The system of claim 42, wherein the circuitry is configured to generate the generated information indicating one or more of the estimated indicative quantit(ies) determined for the internal parameter(s) at a specified time in less than one second from that specified time.~~

~~45. The system of claim 42, wherein the circuitry is configured to use a predetermined indicative quantity for one or more of the internal properties at specified time(s).~~

~~46. The system of claim 42, wherein the circuitry is configured to use an estimated indicative quantity for one or more of the internal properties at specified time(s).~~

~~47.~~2. The system of claim 1, wherein the circuitry is configured to:

determine a calculated sensor temperature at one or more specified times based on at least the measured temperature signal, the measured heat flux signal, one or more of the estimated internal ~~parameter~~ property indicative quantit(ies), and one or more of the remaining internal property indicative quantit(ies) when there are one or more remaining internal properties~~, and one or more effects associated with the estimated thermal contact resistance~~; and

compare the calculated sensor temperature with a measured temperature that is based on the measured temperature signal to determine a difference.

~~48. The system of claim 47, wherein the circuitry is configured to adjust one or more of the estimated indicative quantit(ies) for the internal parameter(s) and the estimated thermal contact resistance based on the difference to produce updated estimated indicative quantit(ies) for the internal parameter(s) and the estimated thermal contact resistance.~~

~~49.~~3. The system of claim 2, wherein the circuitry is configured to adjust ~~one or more of~~ the estimated indicative quantit(ies) for one or more of the internal ~~parameter(s)~~properties ~~and the estimated thermal contact resistance~~ to reduce the difference, and

wherein when the difference is less than a threshold amount or otherwise determined to be minimal, the estimated indicative quantit(ies) for the internal ~~parameter(s)~~propert(ies) ~~and the estimated thermal contact resistance~~ are deemed to be optimally updated and the circuitry is configured to generate information indicating the optimally updated estimated indicative quantit(ies) for the internal ~~parameter(s)~~propert(ies) ~~and the estimated thermal contact resistance~~.

~~50. The system of claim 47, wherein the circuitry is configured to adjust one or more of the estimated indicative quantit(ies) for the internal parameter(s) and the estimated thermal contact resistance using one or more optimization techniques.~~

~~51. The system of claim 47, wherein the circuitry is configured to adjust one or more of the estimated indicative quantit(ies) for the internal parameter(s) and the estimated thermal contact resistance using one or more machine learning techniques.~~

~~52. The system of claim 41, wherein the circuitry is configured to determine the~~

estimated thermal contact resistance independent of the internal parameter(s).

53. The system of claim 41, wherein the circuitry is configured to determine the estimated thermal contact resistance based on the internal parameter(s).

54. The system of claim 41, wherein the circuitry is configured to determine the estimated thermal contact resistance based on a total steady-state thermal resistance of the object.

55. The system of claim 47, wherein the circuitry is configured to adjust one or more of the estimated indicative quantit(ies) for the internal parameter(s) and the estimated thermal contact resistance in real-time.

56. The system of claim 39, wherein the circuitry is configured to determine one or more of the estimated indicative quantit(ies) for the internal parameter(s) using one or more machine learning techniques.

57. The system of claim 39, wherein the circuitry is configured to determine one or more of the estimated indicative quantit(ies) for the internal parameter(s) using one or more thermal mathematical models for the object.

58. The system of claim 57, wherein the one or more thermal mathematical models has a transient temperature solution defined as a function of initial temperature distribution, heat flux, time, space, and the internal parameter(s).

59. The system of claim 57, wherein the one or more thermal mathematical models includes one or more steady-state conditions.

60. The system of claim 58, wherein the initial temperature distribution is based on a steady-state temperature profile.

61. The system of claim 39, wherein the internal parameters include one or more from a list comprising:

R'': steady-state thermal resistance,

x: depth from the surface,

R''_{total}: total steady-state thermal resistance,

U: overall heat transfer coefficient,

k: thermal conductivity,

ρ: density,

C: heat capacity,

ρC: volumetric heat capacity,

$\sqrt{k\rho C}$: thermal inertia,

~~$\alpha = \frac{k}{\rho c}$: thermal diffusivity,~~

~~h: convection heat transfer coefficient,~~

~~$\dot{v}$: flowrate,~~

~~δ: wall thickness,~~

~~τ: time constant, and~~

~~w: blood perfusion.~~

~~62. The system of claim 39, wherein the non-invasive sensor includes thermal insulation to reduce measured signal noise.~~

~~63. The system of claim 39, wherein the non-invasive sensor includes thermal insulation to control an amount of heat transfer occurring through the non-invasive sensor.~~

~~64. The system of claim 39, wherein the temperature sensor is a thin-film thermocouple, a thin temperature sensor, a resistance temperature sensor, or a fiber optic temperature sensor.~~

~~65. The system of claim 39, wherein the heat flux sensor is based on differential thermopile technology.~~

~~66. The system of claim 39, wherein the heat flux sensor is based on thin-film technology.~~

~~67. The system of claim 39, wherein the heat flux sensor is a thin heat flux sensor.~~

~~68. The system of claim 39, wherein the heat flux sensor is a flexible heat flux sensor.~~

~~69. The system of claim 39, wherein the heat flux sensor is based on one or more thermoelectric devices.~~

~~70. The system of claim 39, further comprising one or more external thermal devices for heating and/or cooling the non-invasive sensor.~~

~~71. The system of claim 39, wherein the circuitry controls one or more external thermal devices for heating and/or cooling the non-invasive sensor.~~

~~72. The system of claim 39, wherein the circuitry controls one or more external thermal devices for heating and/or cooling the non-invasive sensor towards a measured heat flux signal and/or a measured temperature signal.~~

~~73. The system of claim 39, wherein the temperature sensor is located on or near a heat flux sensor sensing area.~~

~~74. The system of claim 39, wherein the temperature sensor is between the object~~

and heat flux sensor.

75. The system of claim 39, wherein the heat flux sensor is between the object and temperature sensor.

76. A system for non-invasive sensing of an object having a volume with a surface and an internal region, comprising:

a first non-invasive, heat flux sensor-temperature sensor pair;

a second non-invasive, heat flux sensor-temperature sensor pair;

each of the first and second non-invasive, heat flux sensor-temperature sensor pairs including:

a heat flux sensor having one or more heat flux sensor output terminals;

a temperature sensor having one or more temperature sensor output terminals,

wherein the first and second non-invasive, heat flux sensor-temperature sensor pairs are adapted to be placed at different locations on or near the surface of the object and are subject to a differential heat flux environment, and where the internal region of the object has internal properties indicated by corresponding internal parameter(s) and an internal temperature distribution,

circuitry, coupled to the one or more heat flux sensor output terminals and the one or more temperature sensor output terminals of each of the first and second non-invasive, heat flux sensor-temperature sensor pairs, and configured to:

receive a first measured temperature signal from the temperature sensor in the first non-invasive, heat flux sensor-temperature sensor pair at one or more specified times;

receive a first measured heat flux signal from the heat flux sensor in the first non-invasive, heat flux sensor-temperature sensor pair at one or more specified times;

receive a second measured temperature signal from the temperature sensor in the second non-invasive, heat flux sensor-temperature sensor pair at one or more specified times;

receive a second measured heat flux signal from the heat flux sensor in the second non-invasive, heat flux sensor-temperature sensor pair at one or more specified times;

determine an internal temperature distribution at one or more specified times based on at least the measured temperature signals from the temperature

sensors in the first and second non-invasive, heat flux sensor-temperature sensor pairs at one or more specified times and the measured heat flux signals from the heat flux sensors in the first and second non-invasive, heat flux sensor-temperature sensor pairs at one or more specified times; and

generate information indicating the internal temperature distribution at one or more specified times.

77. The system of claim 76, wherein each respective temperature sensor is between the object and its corresponding heat flux sensor and/or wherein each respective heat flux sensor is between the object and its corresponding temperature sensor.

78. The system of claim 76, wherein the circuitry is configured to determine a measure of heat transfer occurring through the first non-invasive, heat flux sensor-temperature sensor pair and leaving or entering the object at the surface based on the first measured heat flux signal at one or more specified times and/or determine a measure of heat transfer occurring through the second non-invasive, heat flux sensor-temperature sensor pair and leaving or entering the object at the surface based on the second measured heat flux signal at one or more specified times.

79. The system of claim 76, wherein the circuitry is configured to:

determine an indicative quantity for one or more of the internal parameters at one or more specified times; and

determine the internal temperature distribution at one or more specified times based on at least the measured temperature signals from the temperature sensors in the first and second non-invasive, heat flux sensor-temperature sensor pairs at one or more specified times, the measured heat flux signals from the heat flux sensors in the first and second non-invasive, heat flux sensor-temperature sensor pairs at one or more specified times, and one or more of the indicative quantit(ies) determined for the internal parameter(s) at one or more specified times.

80. The system of claim 79, wherein the circuitry is configured to use an estimated and/or a predetermined indicative quantity for one or more of the internal parameters at specified time(s).

81. The system of claim 76, wherein the circuitry is configured to account for one

~~or more effects associated with an estimated thermal contact resistance between the temperature sensor in the first non-invasive, heat flux sensor-temperature sensor pair and the surface of the object.~~

~~82. The system of claim 76, wherein the circuitry is configured to account for one or more effects associated with an estimated thermal contact resistance between the temperature sensor in the second non-invasive, heat flux sensor-temperature sensor pair and the surface of the object.~~

~~83.~~4. A system for non-invasive sensing of an object having a volume with a surface and an internal region, comprising:

a first non-invasive, heat flux sensor-temperature sensor pair;

a second non-invasive, heat flux sensor-temperature sensor pair;

each of the first and second non-invasive, heat flux sensor-temperature sensor pairs including:

a heat flux sensor having one or more heat flux sensor output terminals;

a temperature sensor having one or more temperature sensor output terminals,

wherein the first and second non-invasive, heat flux sensor-temperature sensor pairs are adapted to be placed at different locations on or near the surface of the object and are subject to a differential heat flux environment, and where the internal region of the object has internal properties indicated by corresponding internal parameter(s) and an internal temperature distribution,

circuitry, coupled to the one or more heat flux sensor output terminals and the one or more temperature sensor output terminals of each of the first and second non-invasive, heat flux sensor-temperature sensor pairs, and configured to:

receive a first measured temperature signal from the temperature sensor in the first non-invasive, heat flux sensor-temperature sensor pair at one or more specified times;

receive a first measured heat flux signal from the heat flux sensor in the first non-invasive, heat flux sensor-temperature sensor pair at one or more specified times;

receive a second measured temperature signal from the temperature sensor in the second non-invasive, heat flux sensor-temperature sensor pair at one or more specified times;

receive a second measured heat flux signal from the heat flux sensor in the second non-invasive, heat flux sensor-temperature sensor pair at one or more specified times;

determine an estimated indicative quantity for one or more of the internal ~~parameters~~ properties of the object at one or more specified times based on at least the measured temperature signals from the temperature sensors in the first and second non-invasive, heat flux sensor-temperature sensor pairs at one or more specified times and the measured heat flux signals from the heat flux sensors in the first and second non-invasive, heat flux sensor-temperature sensor pairs at one or more specified times; and

generate information indicating one or more of the estimated indicative quantit(ies) determined for the internal ~~parameter(s)~~propert(ies) of the object at one or more specified times.

~~84. The system of claim 83, wherein the circuitry is configured to determine a measure of heat transfer occurring through the first non-invasive, heat flux sensor-temperature sensor pair and leaving or entering the object at the surface based on the first measured heat flux signal at one or more specified times and/or determine a measure of heat transfer occurring through the second non-invasive, heat flux sensor-temperature sensor pair and leaving or entering the object at the surface based on the second measured heat flux signal at one or more specified times.~~

~~85. The system of claim 83, wherein each respective temperature sensor is between the object and its corresponding heat flux sensor and/or wherein each respective heat flux sensor is between the object and its corresponding temperature sensor.~~

~~86. The system of claim 83, wherein the circuitry is configured to:~~

~~determine an initial indicative quantity for one or more of the internal parameters at one or more specified times; and~~

~~determine one or more of the indicative quantit(ies) for the internal parameter(s) of the object at one or more specified times based on at least the measured temperature signals from the temperature sensors in the first and second non-invasive, heat flux sensor-temperature sensor pairs at one or more specified times, the measured heat flux signals from the heat flux sensors in the first and second non-invasive, heat flux sensor-temperature sensor pairs at~~

~~one or more specified times, and one or more of the initial indicative quantit(ies) determined for the internal parameter(s) at one or more specified times.~~

~~87.~~5. The system of any of claims 1 to 4~~claim 86~~, wherein the circuitry is configured to use an estimated initial indicative quantity for one or more of the internal properties at specified times(s) and/or a predetermined initial indicative quantity for one or more of the internal ~~parameters~~ properties at specified times(s).

~~88.~~6. The system of any of claims 1 to 5~~claim 83~~, wherein the circuitry is configured to ~~account for~~include one or more effects associated with an estimated thermal contact resistance between the temperature sensor(s) ~~in the first non-invasive, heat flux sensor-temperature sensor pair and the surface of the object and/or one or more effects associated with an estimated thermal contact resistance between the temperature sensor in the second non-invasive, heat flux sensor-temperature sensor pair~~ and the surface of the object.

~~89.~~7. The system of any of claims 1 to 6, wherein the circuitry is configured to:

determine the estimated indicative quantit(ies) for one or more of the internal properties at one or more specified times based on at least the measured temperature signal(s), the measured heat flux signal(s), and indicative quantit(ies) determined for one or more of the internal properties.

~~90.~~8. The system of any of claims 1 to 7, further comprising one or more non-NITI based devices, wherein the circuitry is configured to utilize one or more output signals of the one or more non-NITI based devices to determine the estimated indicative quantit(ies) for one or more of the internal properties.

~~91.~~9. A non-invasive sensor adapted to be placed on or near a surface of an object having a volume with a surface and an internal region, where the internal region of the object has internal properties indicated by corresponding internal parameter(s) and an internal temperature distribution, the non-invasive sensor comprising:

a non-invasive, heat flux sensor-temperature sensor pair;

the non-invasive, heat flux sensor-temperature sensor pair including:

a heat flux sensor having one or more heat flux sensor output terminals to provide a measured heat flux signal for a location on or near the surface of the object, and

a temperature sensor having one or more temperature sensor output terminals to provide a measured temperature signal for a location on or near the surface of the object,

wherein the non-invasive sensor is configured to ensure that a mismatch does not exist between the measured heat flux signal and the measured temperature signal.

~~92. The non-invasive sensor of claim 89, further comprising one or more external thermal devices for heating and/or cooling the non-invasive, heat flux sensor-temperature sensor pair.~~

~~93. The non-invasive sensor of claim 90, wherein the one or more external thermal devices include a heater and/or a cooler.~~

~~94. The non-invasive sensor of claim 89, wherein the heat flux sensor is arranged to produce a differential voltage indicative of heat transfer occurring through the heat flux sensor at the object surface.~~

~~95. The heat flux sensor of claim 92, wherein the differential voltage is related to the heat transfer occurring through the heat flux sensor and at the object surface by a calibration constant or a sensitivity constant associated with the heat flux sensor.~~

~~96. The heat flux sensor of claim 92, wherein the differential voltage is related to the heat transfer occurring through the heat flux sensor and at the object surface by a calibration curve or a sensitivity curve associated with the heat flux sensor.~~

~~97. The non-invasive sensor of claim 89, wherein the heat flux sensor is based on thin-film differential thermopile technology.~~

~~98. The non-invasive sensor of claim 89, wherein the heat flux sensor includes two or more thermocouple junctions connected in series to provide a voltage output that is indicative of a temperature difference across a given thermal resistance.~~

~~99. The non-invasive sensor of claim 89, wherein the temperature sensor is based on thermocouple, fiber optic, or thermistor technology.~~

~~100. The non-invasive sensor of claim 89, wherein a thickness of the temperature sensor is less than or equal to a thickness of the heat flux sensor.~~

~~101.~~10. A non-invasive sensor adapted to be placed on or near a surface of an object having a volume with a surface and an internal region, where the internal region of the object has internal properties indicated by corresponding internal parameter(s) and an internal temperature distribution, the non-invasive sensor comprising:

a first non-invasive, heat flux sensor-temperature sensor pair;

a second non-invasive, heat flux sensor-temperature sensor pair;

each of the first and second non-invasive, heat flux sensor-temperature sensor pairs including:

a heat flux sensor having one or more heat flux sensor output terminals;

a temperature sensor having one or more temperature sensor output terminals,

wherein the first and second non-invasive, heat flux sensor-temperature sensor pairs are adapted to be placed at different locations on or near the surface of the object and are subject to a differential heat flux environment.

~~102. The non-invasive sensor of claim 99, further comprising one or more external thermal devices for heating and/or cooling the first non-invasive, heat flux sensor-temperature sensor pair and/or one or more external thermal devices for heating and/or cooling the second non-invasive, heat flux sensor-temperature sensor pair.~~

11. The non-invasive sensor of claim 9 or claim 10, comprising one or more non-NITI based devices to provide one or more output signals for utilization in determining estimated indicative quantit(ies) for one or more of the internal properties.

~~103.~~12. The system of any of claims 1 to 8 or the non-invasive sensor of any of claims 9 to 11 ~~claim 99~~, wherein the heat flux sensor(s) ~~in each of the first and second non-invasive, heat flux sensor-temperature sensor pairs~~ is arranged to produce a differential voltage indicative of heat transfer occurring through the heat flux sensor(s) at the object surface~~first and second non-invasive, heat flux sensor-temperature sensor pairs, respectively~~.

~~104.~~13. The system or non-invasive ~~heat flux~~ sensor~~s~~ of claim ~~101~~12, wherein the differential voltage ~~produced by the heat flux sensor in the first and second non-invasive, heat flux sensor-temperature sensor pairs~~ is related to the heat transfer ~~occurring through the corresponding heat flux sensor-temperature sensor pair~~ by a calibration constant, a sensitivity constant, a calibration curve, or a sensitivity curve associated with the heat flux sensor(s).

~~105.~~14. The system of any of claims 1 to 8 or the non-invasive sensor of any of claims 9 to 13 ~~claim 99~~, wherein the heat flux sensor(s) are based on ~~thin-film~~ differential thermopile technology, thin-film technology, or one or more thermoelectric devices.

~~106.~~15. The system of any of claims 1 to 8 or the non-invasive sensor of any of claims 9 to 14 ~~claim 99~~, wherein the heat flux sensor(s) include two or more thermocouple junctions connected in series to provide a voltage output that is indicative of a temperature difference across a given thermal resistance.

~~107.~~16. The system of any of claims 1 to 8 or the non-invasive sensor of any of claims 9 to 15 ~~claim 99~~, wherein the temperature sensor(s) are based on

thermocouple, fiber optic, semiconductor, or thermistor technology.

~~108. The non-invasive sensor of claim 99, wherein a thickness of the temperature sensor is less than or equal to a thickness of the heat flux sensor.~~

~~109. The system of claim 8, wherein the circuitry is configured to determine one or more estimated indicative quantities based on at least the measured temperature signal and/or the measured heat flux signal.~~

~~110. The system of claim 1, wherein the non-invasive sensor includes multiple heat flux sensors and/or multiple temperature sensors.~~

~~111. The system of claim 1, further comprising one or more non-NITI based devices.~~

~~112. The system of claim 109, wherein the circuitry is configured to use one or more output signals of the one or more non-NITI based devices to determine one or more of the indicative quantit(ies) for the internal parameter(s).~~

~~113. The system of claim 109, wherein the circuitry is configured to use one or more output signals of the one or more non-NITI based devices to determine the internal temperature distribution.~~

~~114. The system of claim 39, wherein the non-invasive sensor includes multiple heat flux sensors and/or multiple temperature sensors.~~

~~115. The system of claim 39, further comprising one or more non-NITI based devices.~~

~~116. The system of claim 113, wherein the circuitry is configured to use one or more output signals of the one or more non-NITI based devices to determine one or more of the estimated indicative quantit(ies) for the internal parameter(s).~~

~~117. The system of claim 76, further comprising one or more external thermal devices for heating and/or cooling the first non-invasive, heat flux sensor-temperature sensor pair and/or one or more external thermal devices for heating and/or cooling the second non-invasive, heat flux sensor-temperature sensor pair.~~

~~118. The system of claim 76, wherein the circuitry controls one or more external thermal devices for heating and/or cooling the first non-invasive, heat flux sensor-temperature sensor pair and/or one or more external thermal devices for heating and/or cooling the second non-invasive, heat flux sensor-temperature sensor pair.~~

~~119. The system of claim 76, wherein the circuitry controls one or more external thermal devices for heating and/or cooling the first non-invasive, heat flux sensor-temperature sensor pair towards a measured heat flux signal and/or a measured temperature signal and/or one or more external thermal devices for heating and/or~~

~~cooling the second non-invasive, heat flux sensor-temperature sensor pair towards a measured heat flux signal and/or a measured temperature signal.~~

~~120. The system of claim 76, wherein each respective heat flux sensor is between the object and its corresponding temperature sensor.~~

~~121. The system of claim 76, further comprising one or more non-NITI based devices.~~

~~122. The system of claim 119, wherein the circuitry is configured to use one or more output signals of the one or more non-NITI based devices to determine the internal temperature distribution.~~

~~123.~~17. The system in any of claims 1 to 8 or the non-invasive sensor of any of claims 9 to 16 ~~of claim 83~~, further comprising one or more external thermal devices for heating and/or cooling the non-invasive sensor, the first non-invasive, heat flux sensor-temperature sensor pair, ~~and/or one or more external thermal devices for heating and/or cooling~~ or the second non-invasive, heat flux sensor-temperature sensor pair.

~~124. The system of claim 83, wherein the circuitry controls one or more external thermal devices for heating and/or cooling the first non-invasive, heat flux sensor-temperature sensor pair and/or one or more external thermal devices for heating and/or cooling the second non-invasive, heat flux sensor-temperature sensor pair.~~

~~125.~~18. The system or non-invasive sensor of claim 17~~83~~, wherein the ~~circuitry controls~~ one or more external thermal devices are configured for heating and/or cooling ~~the first non-invasive, heat flux sensor-temperature sensor pair~~ towards a measured heat flux signal and/or a measured temperature signal ~~and/or one or more external thermal devices for heating and/or cooling the second non-invasive, heat flux sensor-temperature sensor pair towards a measured heat flux signal and/or a measured temperature signal~~.

~~126. The system of claim 83, wherein each respective heat flux sensor is between the object and its corresponding temperature sensor.~~

~~127. The system of claim 83, further comprising one or more non-NITI based devices.~~

~~128. The system of claim 125, wherein the circuitry is configured to use one or more output signals of the one or more non-NITI based devices to determine one or more of the estimated indicative quantit(ies) for the internal parameter(s).~~

~~129. The non-invasive sensor of claim 89, wherein the measured heat flux signal indicates a measure of heat transfer leaving or entering the object at the surface.~~

~~130.~~19. The non-invasive sensor of any of claims 9 to 18 ~~claim 89~~, wherein the non-invasive sensor is useable in a system configured to determine one or more of the internal ~~parameters~~ properties of the internal region of the object.

~~131. The non-invasive sensor of claim 89, wherein the non-invasive sensor is useable in a system configured to determine the internal temperature distribution of the internal region of the object.~~

~~132.~~20. The non-invasive sensor of any of claims 9 to 19 ~~claim 89~~ including multiple heat flux sensors and/or multiple temperature sensors.

~~133. The non-invasive sensor of claim 89, wherein the non-invasive sensor is useable in a system comprising of one or more non-NITI based devices.~~

~~134. The non-invasive sensor of claim 97, wherein the one or more external thermal devices are used for heating and/or cooling the non-invasive, heat flux sensor-temperature sensor pair towards a measured heat flux signal and/or a measured temperature signal.~~

~~135. The non-invasive sensor of claim 99, wherein each of the heat flux sensors are configured to determine a measure of heat transfer leaving or entering the object at the surface.~~

~~136. The non-invasive sensor of claim 99, wherein the non-invasive sensor is useable in a system configured to determine one or more of the internal parameters of the internal region of the object.~~

~~137. The non-invasive sensor of claim 99, wherein the non-invasive sensor is useable in a system configured to determine the internal temperature distribution of the internal region of the object.~~

~~138. The non-invasive sensor of claim 108, wherein the non-invasive sensor is useable in a system comprising of one or more non-NITI based devices.~~

~~139. The system of claim 1, wherein the object is non-biological.~~

~~140. The system of claim 39, wherein the object is non-biological.~~