**CLAIMS**

1. A method for detecting the location of buried heat sources using lock-in-thermography (LIT) system, comprising:

placing a device under test (DUT) on a test system;

repeatedly applying electrical excitation signals at multiple different lock-in frequencies to the DUT;

while the excitation signals are applied to the DUT, imaging the DUT using an infrared (IR) camera;

detecting lateral temperature distribution on a surface of the sample to thereby locate the heat-source laterally;

plotting thermal responses of the DUT to thereby obtain time-resolved waveforms for the multiple different lock-in frequencies;

detecting resulting phase shifts between the electrical excitation signal and the thermal response for each of the lock-in frequencies; and,

analyzing the resulting phase shifts as a function of each of the applied lock-in frequencies to thereby obtain depth location of the electrical active heat source.

2. The method of claim 1, further comprising plotting the phase shifts at each of the lock-in frequencies and analyzing the slope of resulting phase vs. frequency curve to thereby improve z-resolution and measurement reliability.

3. The method of claim 1, further comprising calculating depth related phase shift to frequency behavior by analytical solution of the thermal wave propagation; and,

correlating the calculated depth related phase shift frequency behavior to the measured phase shift to identify the depth of the heat source.

4. The method of claim 1, further comprising calculating depth-related phase shift to frequency behavior by finite element modeling of thermal wave propagation;

correlating the calculated depth-related phase shift frequency behavior to the measured phase shifts to identify the depth of the heat source.

5. The method of claim 1, wherein applying test signal comprises obtaining the test signal from an external source and synchronizing the IR camera to the signal from the external source.

6. The method of claim 1, further comprising:

plotting a time-resolved thermal response measured at selected frequency from the lock-in frequencies and superimposing a plot of lock-in voltage of the selected lock-in frequency; and,

fitting a potential function used for cross-correlation to the plot of the time-resolved thermal response.

7. The method of claim 6, wherein the plotting of the time-resolved thermal response is performed for one full lock-in period.

8. The method of claim 6, wherein fitting a potential functions comprises fitting a sine function.

9. The method of claim 8, further comprising calculating a thermal time delay from a rising edge of the lock-in voltage and a zero-point of the sine function.

10. The method of claim 9, further comprising calculating cross-correlation value comprising a number between 0 and 1, indicating how similar the sine functions and the plot of time-resolved thermal response are.

11. The method of claim 1, and further for each of the lock-in frequencies performing the steps comprising:

plotting a time-resolved thermal response measured at selected frequency from the lock-in frequencies and superimposing a plot of lock-in voltage of the selected lock-in frequency; and,

fitting a potential function used for cross-correlation to the plot of the time-resolved thermal response.

12. The method of claim 1, further comprising:

plotting a time-resolved thermal response measured at selected frequency from the lock-in frequencies;

fitting a plurality of different potential function used for cross-correlation to the plot of the time-resolved thermal response; and,

determining a phase shift from each of the potential functions.

13. The method of claim 12, further comprising comparing each of the phase shifts to theoretically or experimentally derived reference data to yield a defect depth localization.

14. The method of claim 1, further comprising performing on-chip binning to reduce the filed of view of the IR camera.

15. The method of claim 1, further comprising reducing the operational area of the IR camera by adding values of neighboring pixels to generate summation data points, and reading only the summation data points.

16. The method of claim 1, further comprising reducing the field of view of the IR camera after detecting lateral temperature distribution but prior to detecting resulting phase shifts.

17. The method of claim 16, wherein reducing the field of view of the IR camera comprises using a single pixel IR sensor.

18. The method of claim 16, wherein reducing the field of view of the IR camera comprises providing a cursor to an operator to designate the location of the heat-source laterally in x and y.

19. The method of claim 18, further comprising providing the user with the ability to designate size of the reduced field of view.

20. The method of claim 16, further comprising after reducing the field of view, operating the IR camera at a higher frame rate.