

Lock-in infrared thermography as non-destructive test for material characterization

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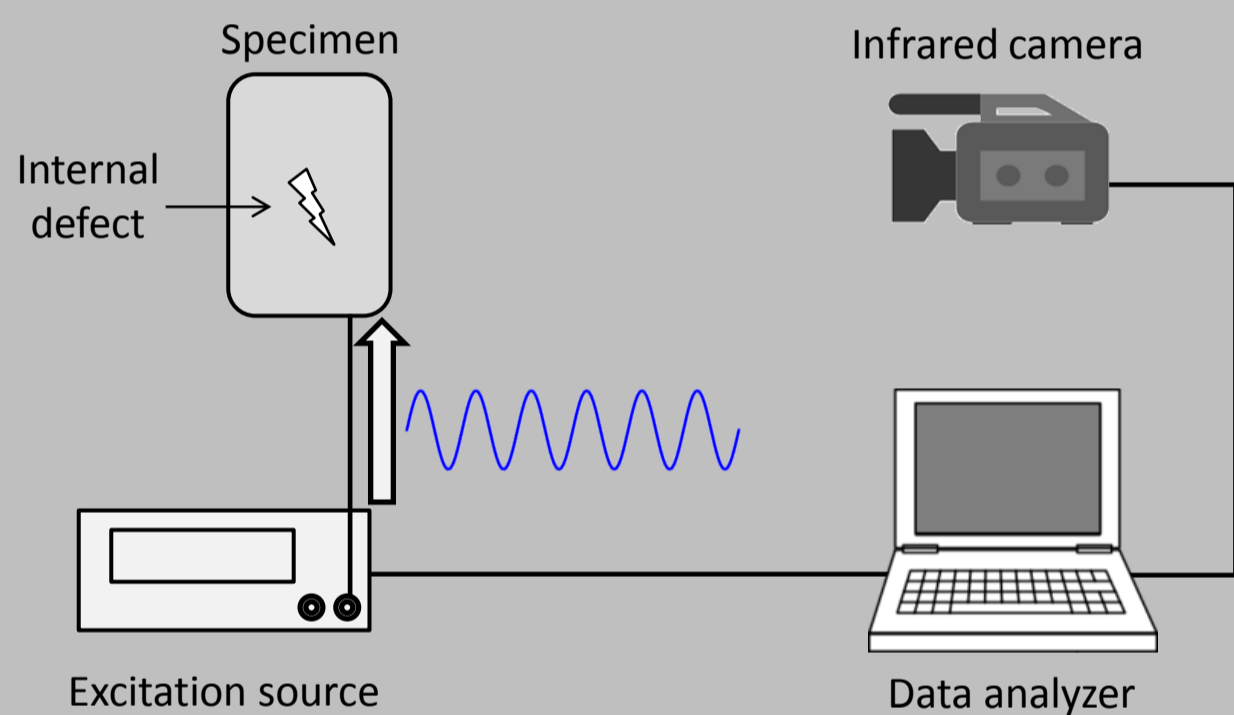
1. Introduction

The Institute for Materials Research, located in Diepenbeek, comprises a research group committed to the development and characterization of new material systems. This is done by means of several destructive testing methods, which is time consuming and economically inefficient.

The main objective of this master's thesis is to realize a demo setup to perform lock-in infrared thermography, a non-destructive testing method for material characterization.

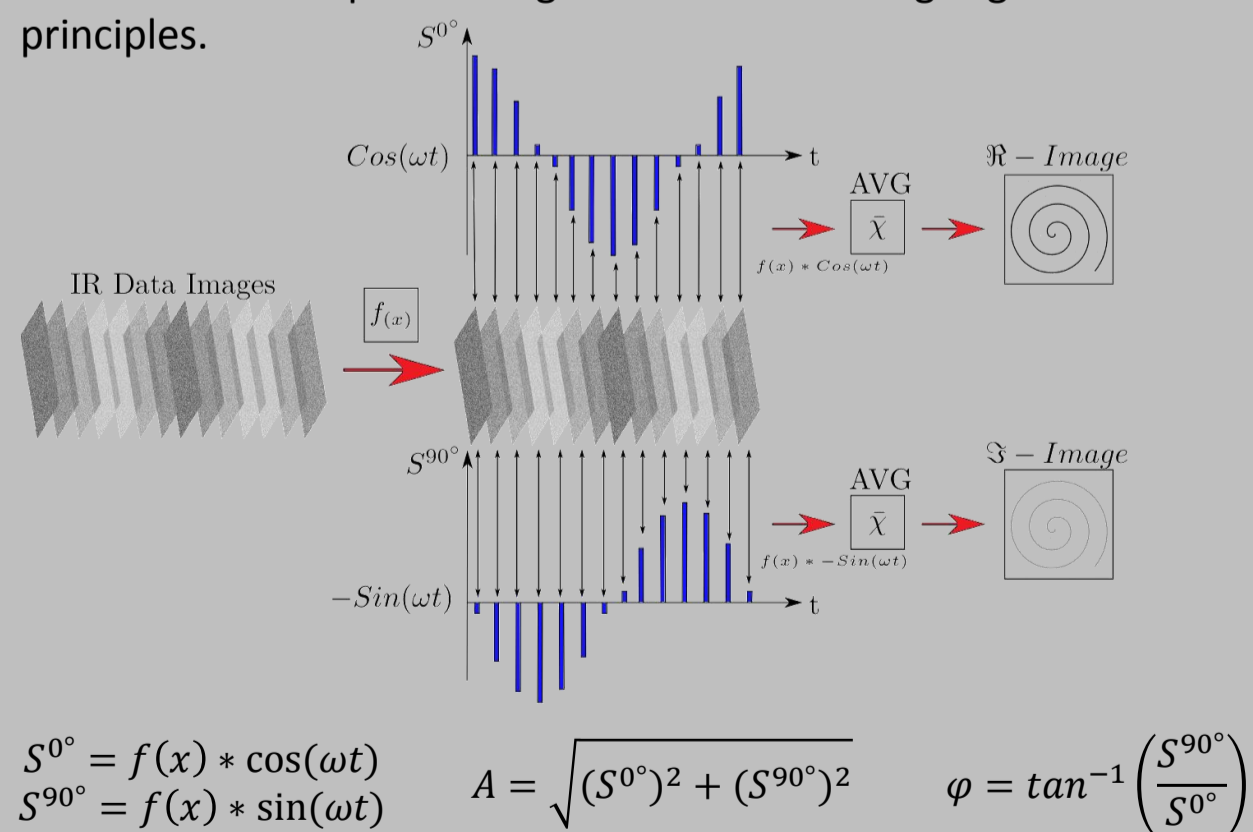
2. Hardware Setup

The hardware is compiled and consists of 3 major parts, i.e. the excitation source, the infrared camera and the data analyzer.



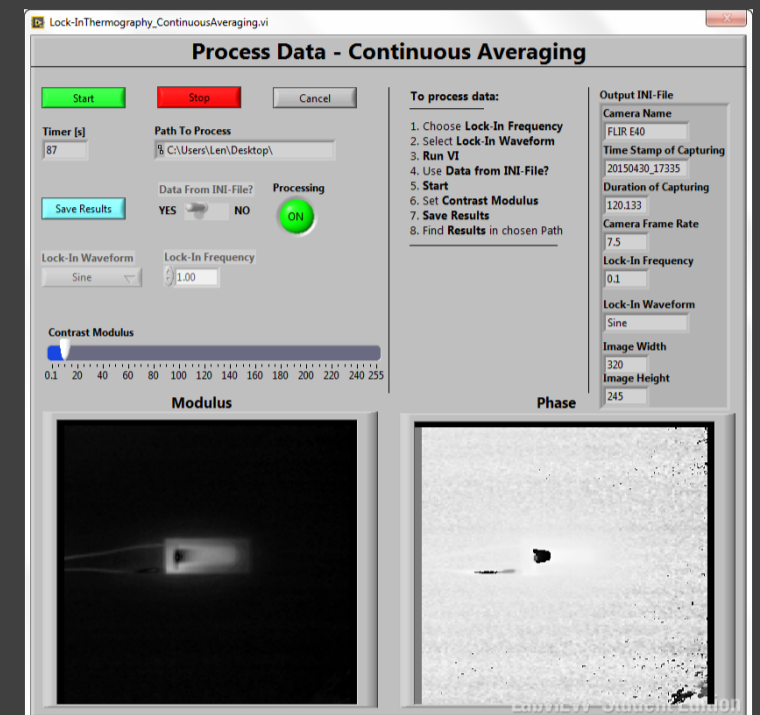
3. Lock-In Algorithm

Each pixel of the data images is multiplied by the sine and cosine. By taking the average of all the data images, it is ensured that the remaining images only contain the signal with the lock in frequency. The modulus and phase image can be found using trigonometric principles.



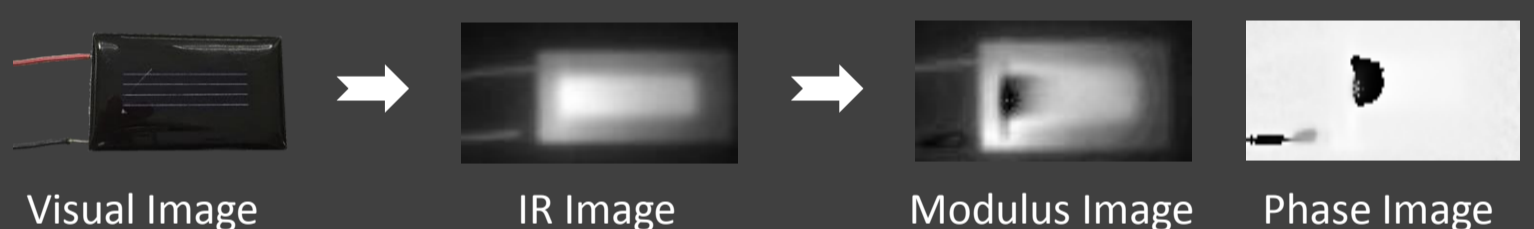
4. Design Results

The software, which stores and processes the data images, was realized using LabVIEW. Algorithms for both continuous and moving averaging are included. The outcome is both the modulus and the phase image of the lock-in experiment.



5. Defect Detection

A lock-in infrared thermography experiment was applied to a small PV-module. Both the visual and infrared image appeared to be normal, but the lock-in algorithm detected a defect in one of the three PV-cells.



6. Conclusions

Lock-in infrared thermography is:

- A relatively fast testing method
- An economically efficient testing method
- Capable of detecting minor damages
 - Such as:
 - Inhomogeneities
 - Delaminations
 - Intern fractures

Selected Publications

- O. Breitenstein, W. Warta, and M. Langenkamp, *Lock-in Thermography*, vol. 10 of *Springer Series in Advanced Microelectronics*. Berlin, Heidelberg: Springer Berlin Heidelberg, 2010.
- M. Vollmer and K.-P. Mollmann, *Infrared Thermal Imaging: Fundamentals, Research and Applications*. John Wiley & Sons, 2011.
- R. Usamentiaga, P. Venegas, J. Guerediaga, L. Vega, J. Molleda, and F. G. Bulnes, "Infrared thermography for temperature measurement and non-destructive testing.," *Sensors (Basel, Switzerland)*, vol. 14, pp. 12305–48, Jan. 2014.

Promotoren / Copromotoren: Prof. dr. ir. Michaël Daenen / Prof. dr. Ward De Ceuninck