Data Analysis within DefinitiveTCM

# Introduction

The analysis component in the DefinitiveTCM code is split among different functions, mirroring almost exactly the files in the original parmerror2 suite of codes. The primary differences are restructurings to: 1) integrate the code into a GUI application, and 2) utilize Object-Oriented Programming paradigms. The equivalent code locations are roughly:

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| --- |
| Table – Correlation between the Original TCM Files and the DefinitiveTCM Code |
| |  |  |  |  | | --- | --- | --- | --- | |  | Definitive TCM | | | | **Original File** | **New File(s)** | **Function Name** | **Line Numbers\*** | | jacobianest.m | Analysis/ThermalWaveNumbers.m | JacobianEstimation() | 330–473 | | loaddata.m | Analysis/FitTCMData.m  Analysis/ThermalWaveNumbers.m | *n/a*  Preformatting() | 133, 212–215  475–515 | | parmerror2.m | Analysis/FitTCMData.m  Resources/Preferences.ini | *n/a*  *n/a* | 148–210, 217–231  16–27 | | parmerrorss.m | Analysis/ThermalWaveNumbers.m | GoodnessOfFit() | 175–189 | | TWM.m | Analysis/ThermalWaveNumbers.m | IsotropicAnalysisStep() | 191–282 | | *\*Line numbers are based on the code version commited April 12,2017* | | | | |

# Changing the basic parameters

Changing the basic parameters, such as the film thickness or Kapitza resistance, can be done by editing the preferences file.

Changing the analysis modes, i.e. the parameters that will be fit during the analysis, is slightly more in­volved. Enabling of parameters is performed in FitTCMData.m in a switch-case statement at lines 177–206. Only three modes are currently available: full, fast, and film.

## Modifying an Analysis Mode

All properties are disabled by default, so the only thing that needs to be done is enabling the parameters to be fit. To fit an additional parameter simply add the line:

fitMask(FitProperties.<Property Name Here>) = true;

using one of the properties listed in Analysis/FitProperties.m. Removing a fitted parameter from any analy­sis mode is performed simply by reversing the above process: either delete or comment-out the line of the corresponding parameter.

A value for the allowed frequencies can also be specified. For example, each of the default analysis modes have maximum frequencies that are specified by a line in the preferences file. This is not required, and a value can be hard-coded in.

## Adding an New Analysis Mode

Create a new case block within the switch-case statement with the name of the new analysis mode in all lowercase letters. If the GUI is going to be used then the name will also need to be added. This is done using GUIDE in MATLAB to edit GUI/StartAnalysis.m. Once the Start Analysis window is open in GUIDE, locate the control named ModelPopup and edit it. Add the name of the additional mode to the list in the String property. Save the changes and everything should be good to go.

# Advanced Modifications

As stated previously, much of the code is copied verbatim from the original files. A few modifications have been made to improve performance, but hopefully these will be self-explanatory. Refer to Table 1 for the correlations between the different code bases.

# Running the Analysis

The new analysis code can be simply used by running DefinitiveTCM through the analysis GUI.

However, in some cases it may be convenient to run the code outside of the pretty little GUI, such as when manual inspection of the data is desired. This is done primarily through FitTCMData.m. For detailed information the documentation of FitTCMData.m can be accessed by running:

help FitTCMData

from the MATLAB command prompt.

Before running FitTCMData it is necessary to 1) ensure that you are in the root directory for DefinitiveTCM, and 2) the folder Analysis is part of MATLAB’s variable PATH. These requirements will ensure that the Database.xlsx, Preferences.ini, and Settings.ini files can be found.

Start an analysis by running:

results = FitTCMData(<DataFile>, <FilmMaterial>, <FilmThickness>,

‘SubstrateName’, <SubstrateMaterial>,

‘AnalysisModel’, <AnalysisModelName>,

‘FitAmplitudes’, <True or False>,

‘Magnification’, <Magnificationfactor>)

Only the first three arguments are required. It is recommended to provide a substrate name, otherwise the program will try to extract it from the name of the data file. The default values for the remaining parameters are:

* AnalysisModelName: Fast
* FitAmplitudes: found in Settings.ini
* Magnification: found in the data file

The return value results is a structure containing the following fields:

* analyzer
  + ThermalWaveNumber object containing all the details of the analysis
  + See ThermalWaveNumber.m for information about the available properties
* allProperties: an array of the property values used for the fitting, including the final values of the fitted parameters
* fittedPropertiesMask: an array of the same dimension as allPropertites indicating which parameters were constant during the fitting and which parameters were fitted
* chiSquared: final chi-squared value
* fminSearchOutput: a structure containing the following fields:
  + x: the final values of the fitted parameters
  + fval: the final chi-squared value
  + exitFlag: any special exit conditions (none, user canceled, iterations exceeded, etc…)
  + output: more details about the optimization process
* standardError: an array containing the results of the error analysis