LexTech

AFGROW.NET

AFGROW European Workshop 2016

AFGROW Release 5.3 and beyond

Alex Litvinov, James Harter,

LexTech, Inc

Feature List for the release 5.3

- **64 bit version - 100%**
- **Converted internal strings from western character set to Unicode – 100%**
- **New spectrum format in AFGROW - 80%**
- **New weight functions solutions (crack at hole, stress distribution in the C-direction for part through cracks) -99%**
- **Using different material data as a function of spectrum data**
- **Applying different material data to different crack directions**
- **Ability to Replicate Results From Previous Versions (back to Version 5.01)** - 20%
- **Option to Save Input File With Retardation State Data for Later Restart – 30%**
- Undo-Redo
- **New solution for a corner crack at the countersink knuckle – 50%**
- **Server based material database – requested by Gulfstream – 50%**
- **Convert material data from AFMAT to a useable format in AFGROW**
- **Bearing solution for corner crack(s) at a countersunk hole – 15%**
- **Bearing solution for the advanced through crack(s) at hole model – 100%**
- AFGROW output post processing
- **New 2D table of the residual stress data (similar to the 2-D user defined beta) 90%**

Bold – Work started
Red – High Priority
Blue - Finished

Less Time Consuming Requests

- Output intervals printed in "hours" if the option to display life in hours is selected in the Output Intervals tab, the crack length plots also should be converted to hours
- In the Propagation Limit tab, the option to stop at a cycle limit should be automatically switched to hours if the User has elected to display the life in hours.
- Add some type of warning in the lug dialog box to let User's know which B.C.s are being used - or at least notify them that the B.C.s are set in the Predict, Preferences dialog.
- Consider adding a failure criterion based on R-curve data
- Consider adding more warning messages to Users about input parameters than could result in poor life predictions. The concern here is for more novice Users who may be tempted to think that AFGROW's User Friendly Interface is a substitute for a good working knowledge of Fracture Mechanics.
- Add ability to open AFGROW input dialogs by clicking on items in the tree view

Less Time Consuming Requests

- **Consider adding an option to control the % of the axial load solution that is used to approximate the out-of-plane bending solution for straight through-the-thickness cracks.– 50%**
- Add a notification in the weight function dialog box to explain the limitations of the stress distributions for part-thru cracks.
- **Add the capability to use the current 2-D User-Defined Beta model for 2, inter-dependent through cracks that can be assigned different plate thickness values. This is needed to accommodate the NASGRO crack growth rate model that is a function of thickness, but would also allow the local stress state to be estimated independently for each crack. It would also be a quick and easy way to solve additional cases without developing a Plug-In module. An additional crack growth model could be added to the Classic Interface showing an image of an "L" section with a crack defined along each leg with 2 thickness parameters.**
- **Add single corner crack model with the finite height – provided by SAFE, Inc**

Less Time Consuming Requests

- Add a solution for stiffened panels
- Add the ability to account for interference fit fasteners
- Increase comment capability
- Add residual strength plot
- Add a plug-in model variable that can return the cycle count
- Add a block size variable for constant amplitude loading (COM)
- Add the ability to randomize load levels within a given sub-spectrum in the Spectrum Manager.
- Add the ability to normalize and de-normalize a spectrum in the spectrum manager

Less Time Consuming Requests

- De-couple the beta calculation and prediction processes (Allow a plugin model to use standard/advanced models)
- Add/Fix the ability to manage multiple instances of AFGROW using the COM API.
- Add context sensitive help to AFGROW dialogs
- Access plugin models through COM

Material data from AFMAT converted to tabular lookup format in AFGROW

2000 Series	7000 Series	7000 Series (cont)	Steel	Nickel-Based Superalloy
2024-T3 L-T LAB AIR SHEET	7010-T73651 L-T LAB AIR PLATE	7075-T76511 L-T LHA EXTRUSION	15-5PH H1025	ASTROLOY 901
2024-T351 L-T LAB AIR PLATE	7050-T74 L-T LAB AIR FORGING	7150-T7751 LAB AIR PLATE	17-4PH H1025 LAB AIR T-L ROUND BAR	IN100
2024-T3511 L-T LAB AIR EXTRUTION	7050-T7451 L-T HHA	7150-T77511 LAB AIR EXTRUSION	300M	INCONEL 718 C-R LAB AIR DISC
2024-T42 L-T LAB AIR PLATE	7050-T73511 L-T HHA EXTRUSION	7175-T736 L-T HHA FORGING	316L (800)	WASPALOY
2024-T851 L-T LAB AIR PLATE	7050-T7452 L-T Forging Lab air	7175-T74 L-T LAB AIR FORGING	4340	
2124-T851 L-T LAB AIR PLATE	7050-T73651 L-T LAB AIR Plate	7178-T6 L-T LAB AIR SHEET	PH13-8Mo-H1000	
2219-T87 T-L LAB AIR PLATE	7050-T74511 L-T LA EXTRUSION	7475-T761 L-T LAB AIR SHEET	PH13-8Mo-H1050	
2324-T39 L-T LA & HHA	7050-T76511 L-T LAB AIR EXTRUSION	7475-T7351 L-T HHA PLATE	A508 T-L PWR H2O FORGING	
2091-T8 T-L HHA PLT & SHT	7050-T76511 L-T STW EXTRUTION	7475-T7651 L-T LAB AIR PLATE		
2090-T86 T-L LAB AIR TEE EXTRUSION	7075-T76 L-T LHA SHEET	7475-T7351 L-T LAB AIR PLATE		
	7075-T651 L-T LAB AIR Plt & Extr	X7090-T7E69 S-T GN2 Plate		
	7075-T7351 L-T LAB AIR PLATE			
	7075-T73511 L-T LAB AIR EXTRUSION			
	7075-T6 L-T LAB AIR SHEET			
	7075-T7651 L-T LHA PLATE			

New weight functions solutions

- Added 3 new solutions
  - Corner cracks with stress distribution along the C direction
  - Single through edge crack with symmetry condition at the crack edge
  - Single through edge crack with symmetry condition at the edge away from the crack
- Status: Finished coding the solutions, coding verification is done, testing solutions accuracy and applicability, AFGROW GUI modified
- To do: finish testing the accuracy and applicability of the solutions

64 Bit AFGROW Performance Test

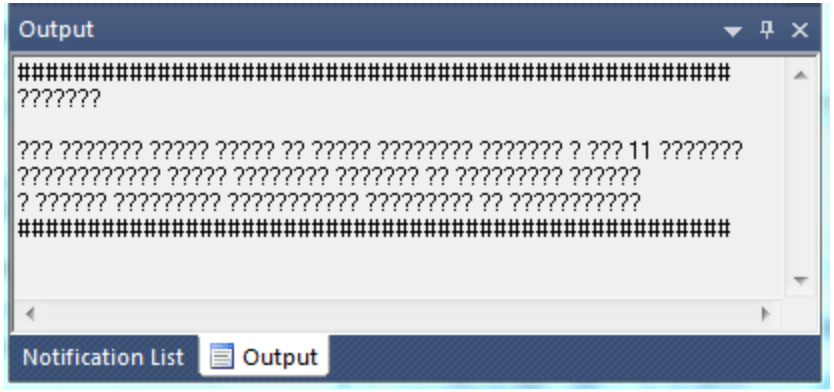
Advanced double cracked hole with offset

Model	Spectrum	Time 5.2 (sec)	Time 5.3 (sec)	Difference
Multipoint	FALSTAF	122	90	35.56%
Multipoint	Const Amplitude	8	6	33.33%
2 points	FALSTAF	73	62	17.74%
2 points	Const Amplitude	5	4	25.00%

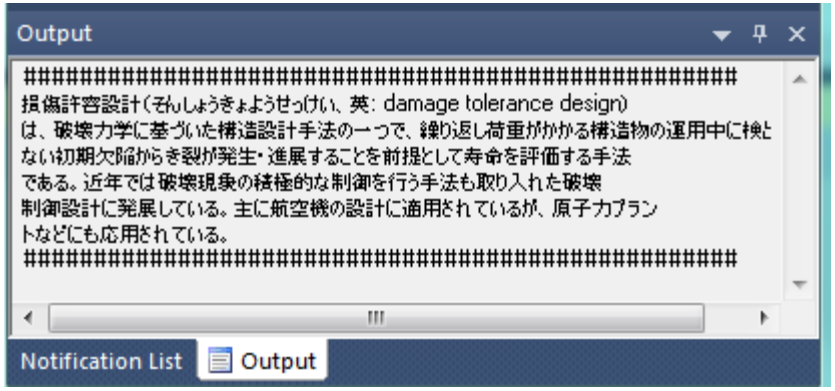
Unicode

- Provides ability to have localized strings in AFGROW, like comments, material names, etc.
- Supports localized file and folder names

5.02



5.03



New solution for a corner crack at the countersink knuckle

- Based on Jody Cronenberger master thesis
- Tension loading only
- Solution Space:
  - D/T – 0.3 to 2.6;
  - Cd (Countersunk Depth)/T - 0.001 to 0.99 (0.15),
  - C/T - 0.0125(D/T) +0.002 to 2.5(D/T)
  - A/C/T – 0.5 to 4
- Status: Finished coding the solution implementation
- To do: Understand the solution boundaries and do verification runs, add COM API support, finish GUI integration

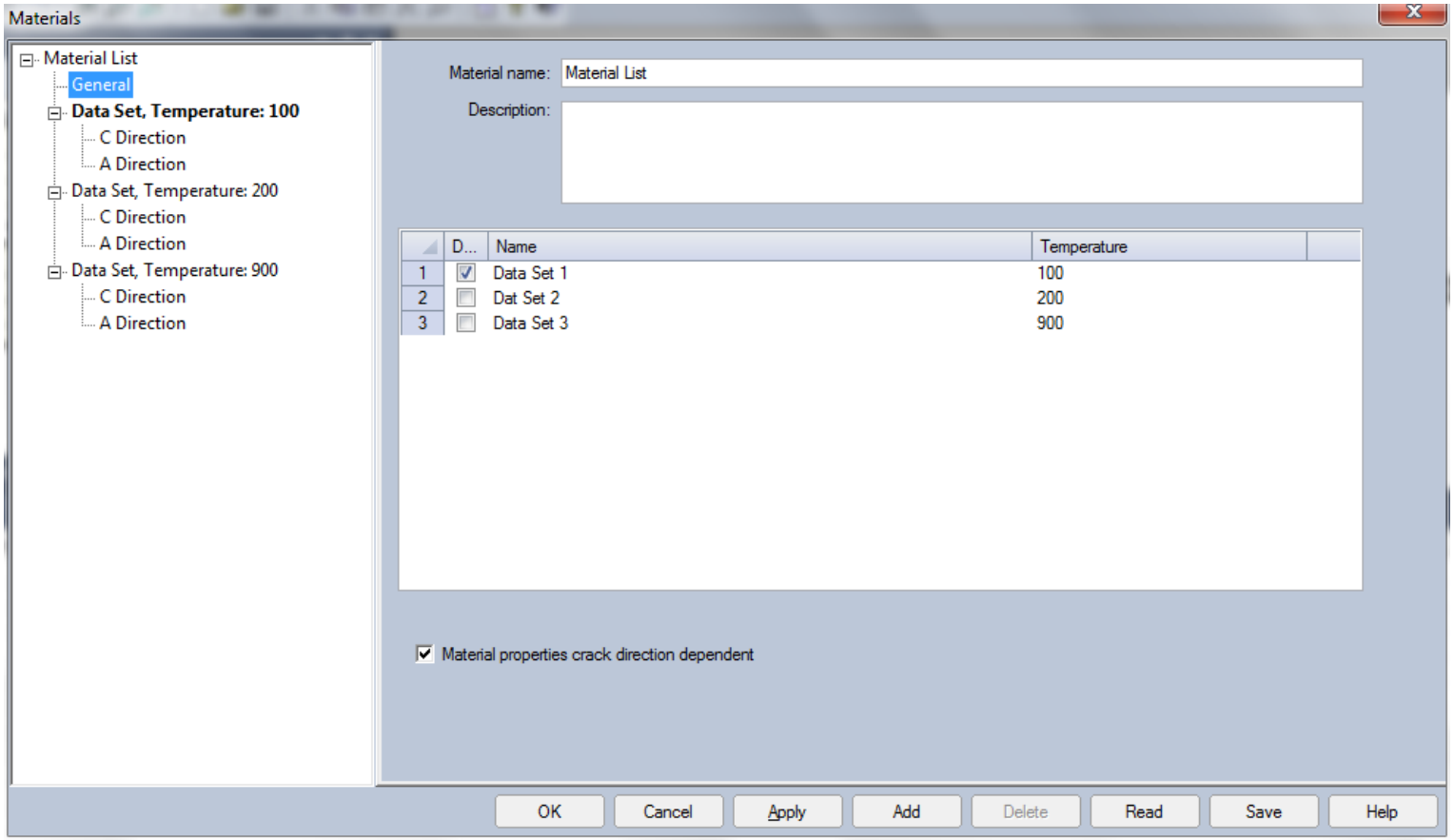
Using different material data as a function of the spectrum

- Status: Finished the Spectrum Manager changes, finished AFGROW coding
- Material data will consist of different material “sets”
- One material “set” is always default
- Material sets can be tagged for different conditions
- Only the temperature “tag” can be used right now
- Applicable only for tabular lookup data, but code infrastructure has been changed to handle any AFGROW material model if necessary, and requires only GUI changes
- Requires a spectrum with temperature “tags” applied to the sub-spectra
- Must be used with the new XML spectrum format
- New XML tabular lookup data file format
- Ability to use old tabular lookup data files for either growth direction
- The resulting DAX input file is backward and upward compatible

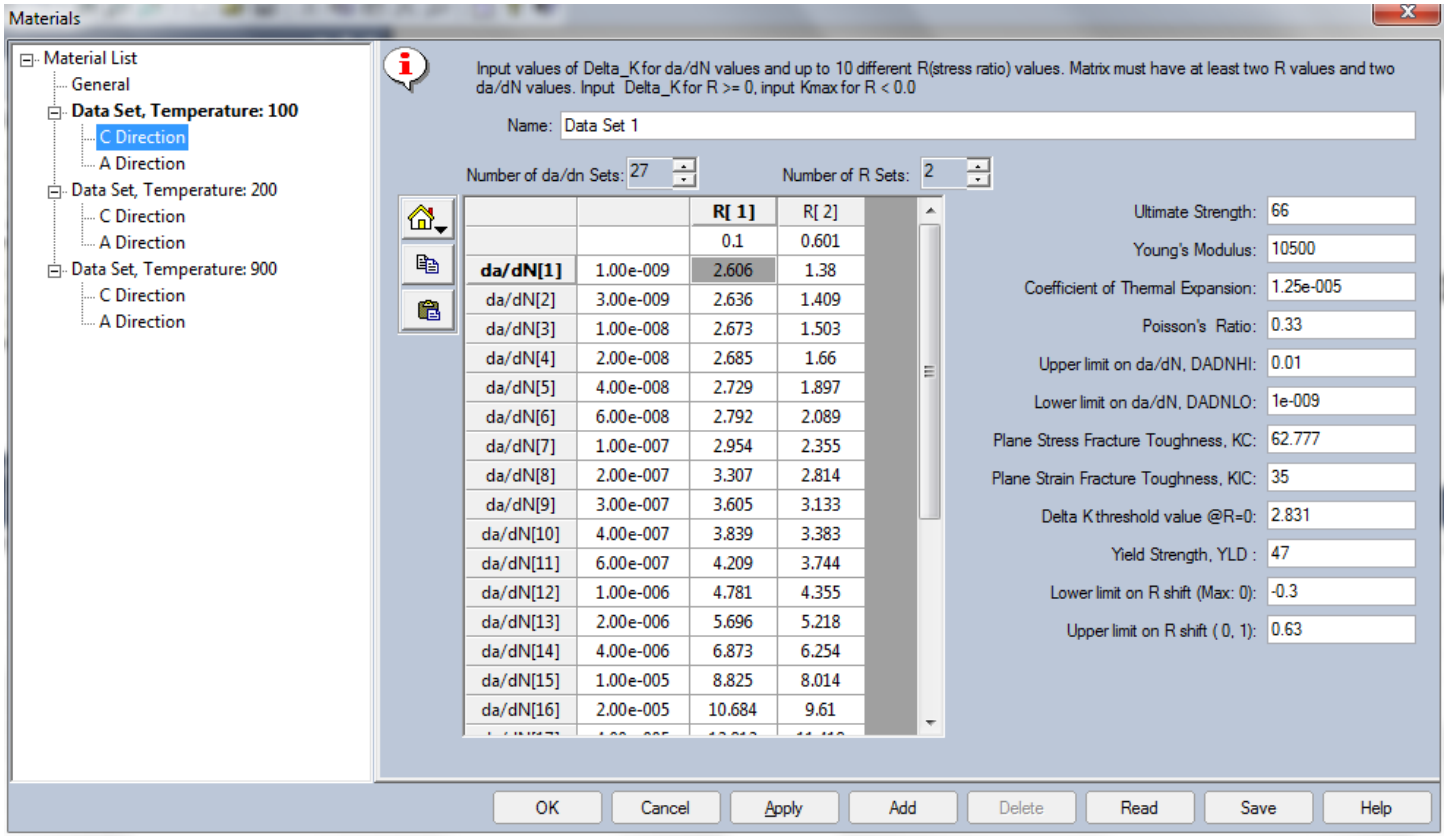
Applying different material data to different crack directions

- Status: Finished AFGROW coding
- Works only with A and C directions (Ct and C direction use the same material data)
- Applicable only for tabular lookup data, but code infrastructure has been changed to handle any AFGROW material model if necessary, and requires only GUI changes
- C direction is always the default direction
- Will not work with the Advanced multipoint corner crack(s) at a hole model
- Can be used in conjunction with the "Using different material data as a function of spectrum" change
- DAX file is backward and upward compatible
- Plugin model needs to be changed to handle different material data to the different crack directions

New Material features dialog changes – General

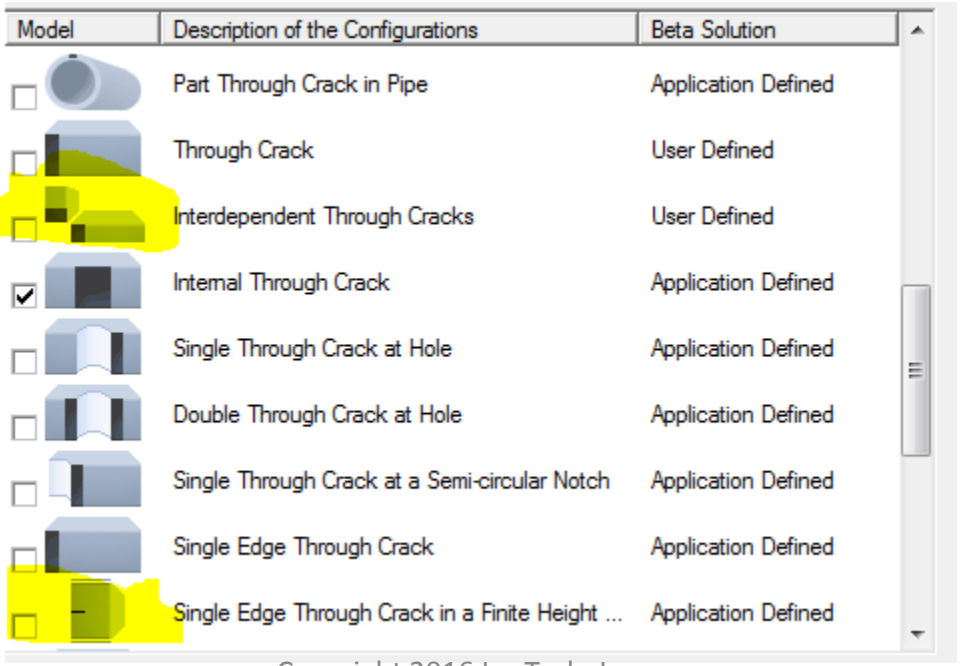


New Material features dialog changes - Material Set Property



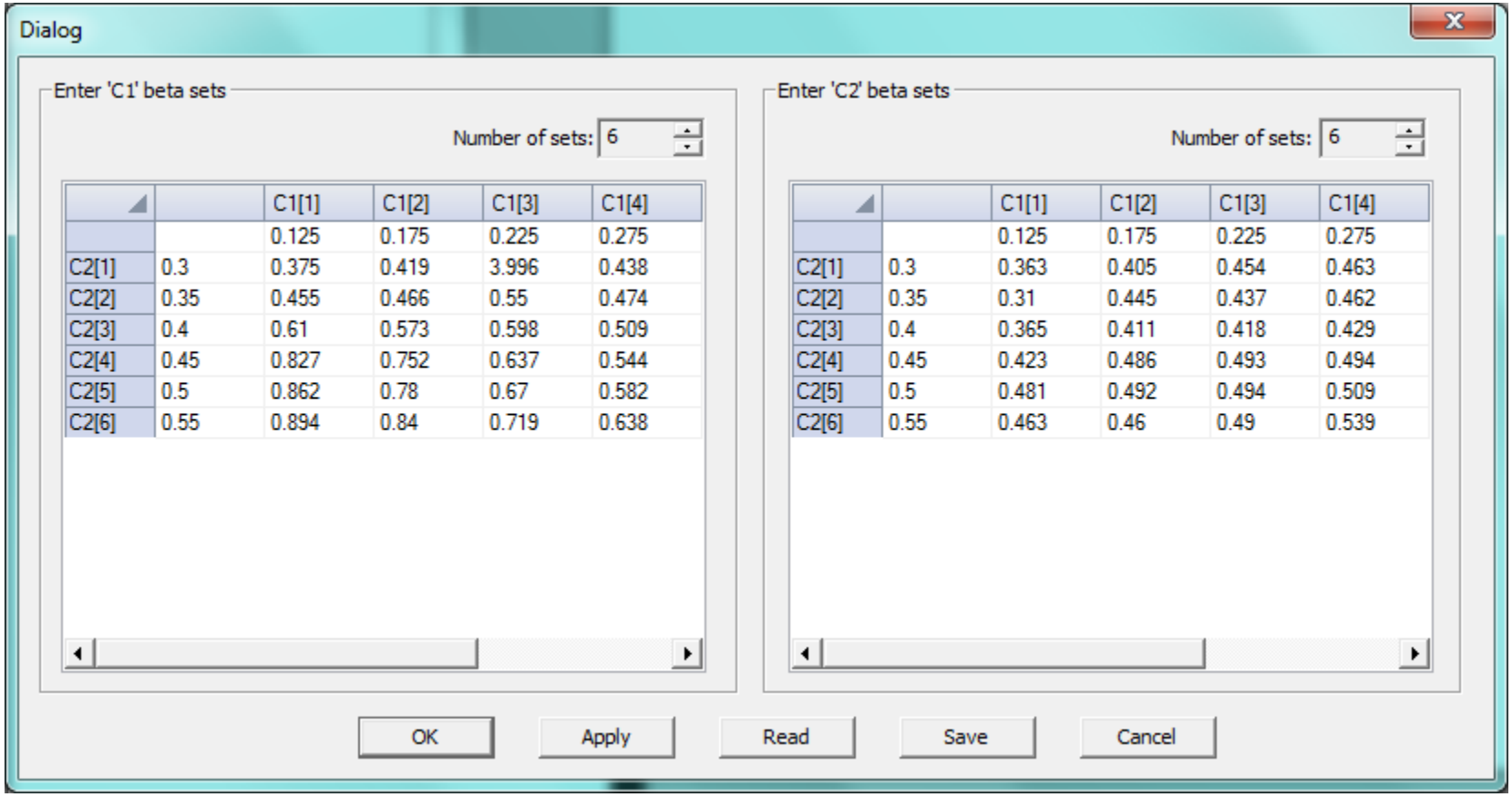
New Classic Models

- Single corner crack model with the finite height
- 2 inter-dependent through cracks that can be assigned different plate thickness values



2 inter-dependent through cracks

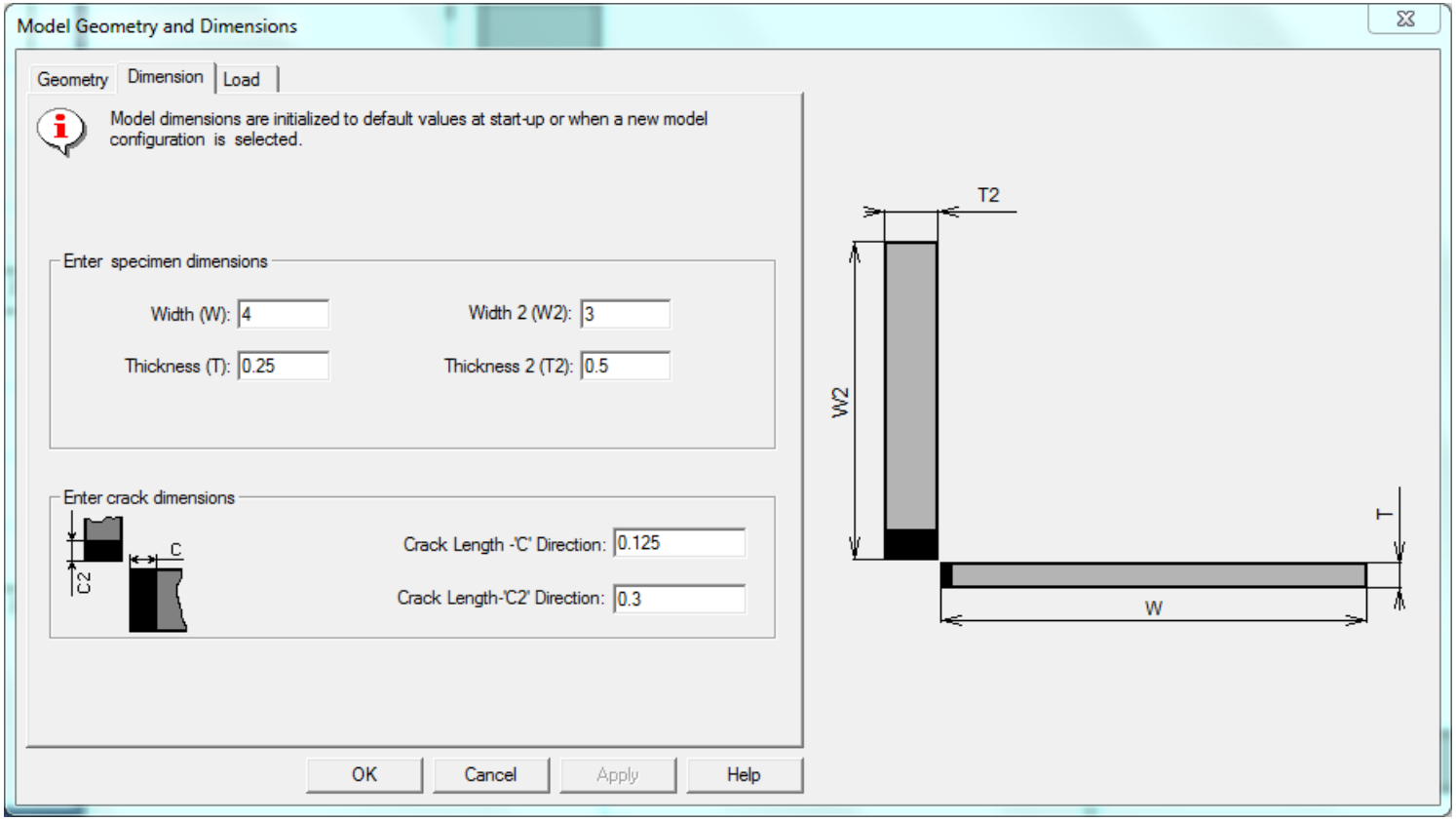
2 inter-dependent through cracks: user defined beta



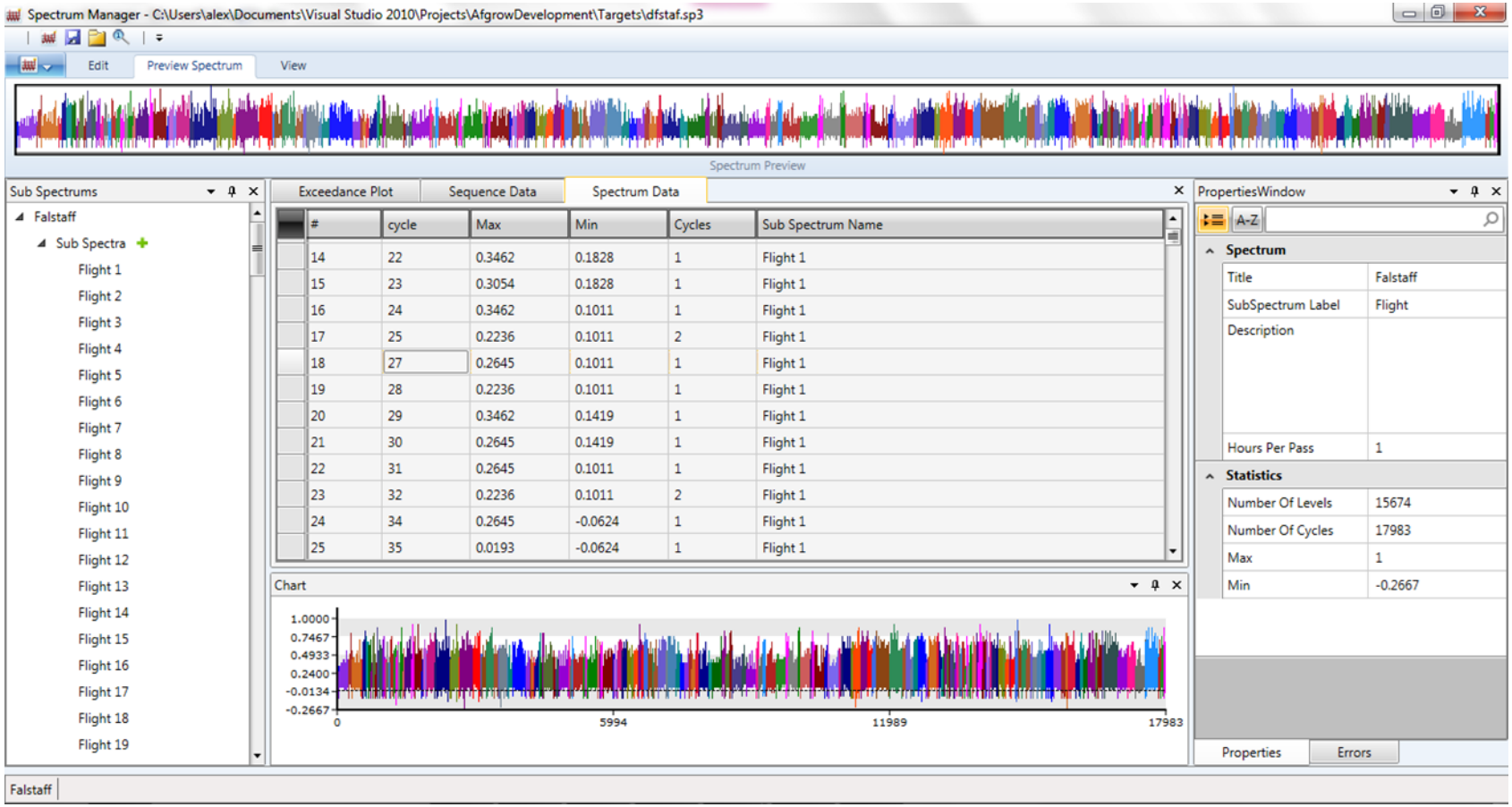
		C1[1]	C1[2]	C1[3]	C1[4]
		0.125	0.175	0.225	0.275
C2[1]	0.3	0.375	0.419	3.996	0.438
C2[2]	0.35	0.455	0.466	0.55	0.474
C2[3]	0.4	0.61	0.573	0.598	0.509
C2[4]	0.45	0.827	0.752	0.637	0.544
C2[5]	0.5	0.862	0.78	0.67	0.582
C2[6]	0.55	0.894	0.84	0.719	0.638

		C1[1]	C1[2]	C1[3]	C1[4]
		0.125	0.175	0.225	0.275
C2[1]	0.3	0.363	0.405	0.454	0.463
C2[2]	0.35	0.31	0.445	0.437	0.462
C2[3]	0.4	0.365	0.411	0.418	0.429
C2[4]	0.45	0.423	0.486	0.493	0.494
C2[5]	0.5	0.481	0.492	0.494	0.509
C2[6]	0.55	0.463	0.46	0.49	0.539

2 inter-dependent through cracks: Model Dimensions

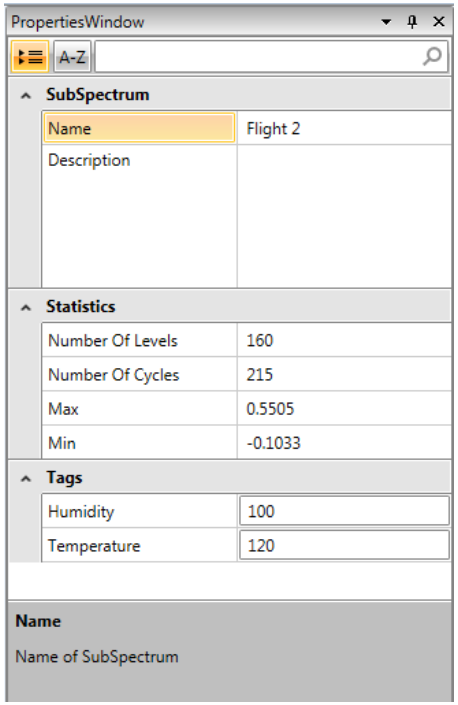


Spectrum Manager

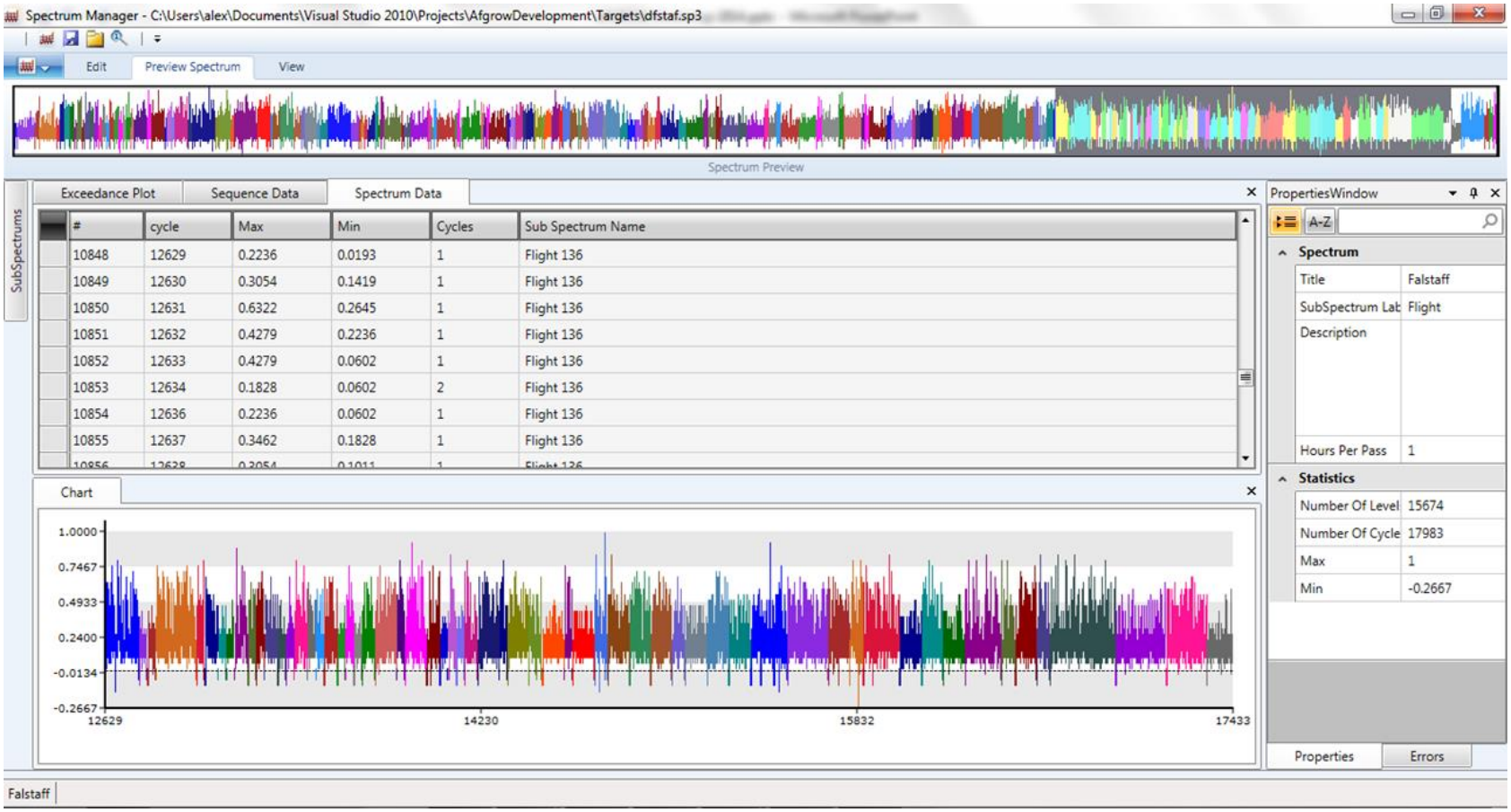


Spectrum Manager Overview

- Visual spectrum design
- Spectrum level reordering
- Sub-spectra organized in any user-defined sequence
- Sub-spectra may be placed in the sequence more than once
- Sub-spectra may be re-ordered in the sequence
- Spectrum statistics at a glance
- Exceedance curve
- Sub-spectra tagging for future analysis
- Synchronized data views
- Spectrum level damage tagging



Synchronized Views



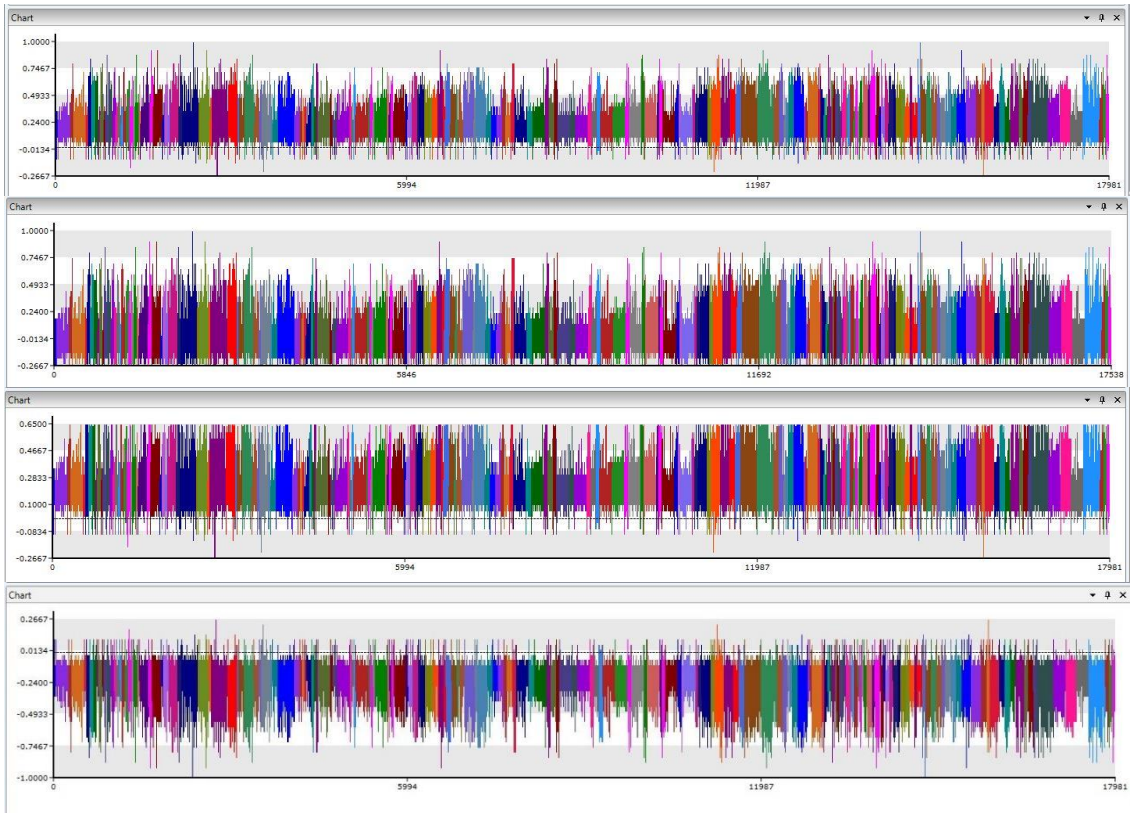
Stress Ratio Distribution Plot

Spectrum Manipulation

Truncation

Clipping

Reversing



Three Channel Sprctra

Beyond Release 5.3

- New weight functions
- Corrosion effects
  - d(geometry)/dt models: intergranular corrosion model, exfoliation corrosion modeling, and user defined equation model.
  - Only one of three can be used at the same time
  - Initial crack size: pitting and crevice model. Only one of two can be used at the same time
- MSD
- New Advanced solutions