

AFGROW Workshop 2010 - Layton, UT

Using the On-Line Material Database

Alex Litvinov, James Harter

LexTech, Inc

Observations

- Damage tolerance evaluations of aircraft structures are never better than the quality, applicability, and availability of the material properties used for the analyses.
- Test data are needed to generate input for life prediction applications and to validate the results
- Data exists but is not easily accessible or searchable

CRACK GROWTH DATABASE V3.1 for Windows 95 and ACCESS 97



- Developed at Purdue University under contract with AFRL-VASM
- Desktop application
- Needed MS ACCESS to be installed
- Super Slow
- Unsupported Scripting Language, that made database unusable
- Hard to search

Goals

- Create an interactive database solution to collect, store and present data
- Make it the foundation for an application that can store material data for crack growth analysis
- Allow seamless integration with other applications

CRACK GROWTH DATABASE → AFMAT

Was

The screenshot shows a desktop application window titled "Local AN TEST". It features a complex form with multiple sections for data entry. The "Record ID" is "a123_anj1000". The "Material Name" is "BERYLLIUM/BERYLLIUM ALLOYS". The "Alloy Name" is "my alloy". The "Condition Heat Treatment" is "WQ". The "Product" section shows "Form Name" as "Extruded Bar", "Thickness" as "1", and "Width" as "2". The "Specimen" section shows "ID" as "321-000", "Orientation" as "T", and "Design" as "1". A table at the bottom displays test data:

RecID	Data Code	Max. Load	Min. Load	CYCLES	Crack Length Front Face 1	Cra
a123_anj1000	T	2	1	100	4000	
a123_anj1000	T	3	8	1000	4356	
a123_anj1000						

Now

The screenshot shows a web browser displaying the "AFGROW | AFMAT" website. The page title is "Online Crack Growth Database". It features a navigation menu with "Home", "Product", "Reference", "Specimen", and "Test Profile". A table lists various materials and their associated data:

Alloy	Product	Reference	Specimen	Test Profile
Alloy Steels				
Aluminum				
Beryllium/Beryllium Alloys				
Brass				
Bronze				
Copper/Copper Alloys				
Iron Alloys				
Magnesium Alloys				
Mild/Aluminum-Nickel/Aluminum Alloys				
Nickel Based Super Alloys				
Nickelium/Nickelium Alloys				
Solders				
Stainless Steels				
Titanium Alloys				
Zinc Alloys				

- Desktop application
- Hard to search
- Obsolete technology
- Unstructured data

- Web based
- More ways to search data
- Easy to Use/Always up to date
- Structured data

AFMAT Content

- Came from 3 (5) different organizations
- 1229 Sources/Publications
- 11 Different property types
- More than 600 different materials (metals)
- These data can not be used directly as input for crack growth prediction without preprocessing

AFMAT Content – Sources

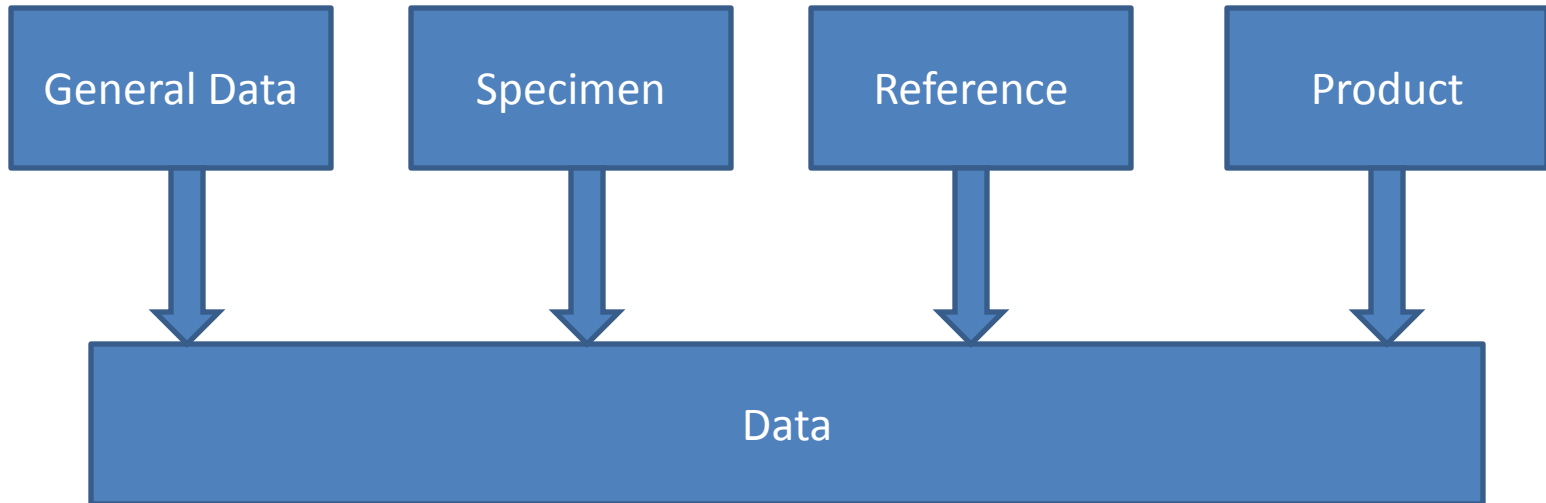
Total data entries: 20240

- NASA - 1574
- AIR FORCE - 11850
- NASA - Johnson Space Center - 31
- Purdue Aging Aircraft Data - 77
- Additional NASA Data - 6708

AFMAT Content – Property Types

- Plane Strain Fracture Toughness (K_{1C}) - 7394
- Plane Stress Fracture Toughness (K_C) - 3927
- Fatigue Life (a vs N) - 2133
- Fatigue Crack Growth Rate (da/dN vs delta K) - 5336
- Sustained Load Growth Rate (da/dt vs K_{max}) - 112
- K₁ Environmentally Assisted Cracking - 469
- R-Curve (K_R) - 89
- J-Integral Fracture Toughness - 276
- Fracture Toughness Measured By CTOD - 125
- R-Curve (J_R) - 378

Data Structure



Everything is Referenced to the Material

AF Mat > Test Profile

Specimen

No conditions specified.

Alloy Is 0.22MO

Display Results

- ALLOY STEELS
- Aluminum
- BERYLLIUM/BERYLLIUM ALLOYS
- BRASS
- BRONZE
- COPPER/COPPER ALLOYS
- IRON ALLOYS
- MANGNESIUM ALLOYS
- MOLYBDENUM/MOLYBDENUM ALLOYS
- NICKEL BASED SUPER ALLOYS
- NIOBIUM/NIOBIUM ALLOYS
- SOLDERS
- STAINLESS STEELS
- TITANIUM ALLOYS
- ZINC ALLOYS

Id	Alloy	Data Source	Condition Heat Treatment	Property Type	Environment
20240	7075-T6	Purdue Aging Aircraft Data		Fatigue Life (a vs N)	Unknown
1222	TI-6AL-4V	AIR FORCE	AS RECD	Plane Strain Fracture Toughness (K1C)	Unknown
1223	TI-6AL-4V	Additional NASA Data	AS RECD	Plane Strain Fracture Toughness (K1C)	Unknown
1224	TI-6AL-4V	Additional NASA Data	AS RECD	Plane Strain Fracture Toughness (K1C)	Unknown
1225	TI-6AL-4V	Additional NASA Data	AS RECD	Plane Strain Fracture Toughness (K1C)	Unknown
1226	TI-6AL-4V	Additional NASA Data	AS RECD	Plane Strain Fracture Toughness (K1C)	Unknown
1227	C11000(ETP BUS BAR)	Additional NASA Data	AS RECD	Fatigue Crack Growth Rate (da/dN vs delta K)	LAB AIR
1228	C11000(ETP BUS BAR)	Additional NASA Data	AS RECD	Fatigue Crack Growth Rate (da/dN vs delta K)	LAB AIR
1229	TI-6AL-4V	AIR FORCE	AS RECD;PROBABLY MA	K1 Environmentally Assisted Cracking	3.5PCT NAACL
1230	304	NASA	AS ROLL	Fatigue Crack Growth Rate (da/dN vs delta K)	LAB AIR
1231	ASTM A553(TYPE I)	Additional NASA Data	AS ROLL	Fatigue Crack Growth Rate (da/dN vs delta K)	LAB AIR
1232	300M	Additional NASA Data	AUST/1000F;OQ;T/1200F	Fatigue Crack Growth Rate (da/dN vs delta K)	LAB AIR
1233	4340	AIR FORCE	AUST/1350F;OQ;T/750F/1.25HR	K1 Environmentally Assisted Cracking	3.5PCT NAACL
1234	300M(COARSE GRA	AIR FORCE	AUST/1500F/0.5HR;OQ;T/400F/2+2HR	K1 Environmentally Assisted Cracking	3.5PCT NAACL
1235	300M(FINE GRAIN	AIR FORCE	AUST/1500F/0.5HR;OQ;T/400F/2+2HR	K1 Environmentally Assisted Cracking	3.5PCT NAACL

Material – Filtered with the data

AF Mat > Test Profile

Specimen

X >> Property Type Is Fatigue Crack Growth Rate (da/dN vs delta K)

X >> and Environment Is AIR

and Alloy Is 0.22MO

- ALLOY STEELS
- Aluminum
- NICKEL BASED SUPER ALLOYS
- STAINLESS STEELS
- TITANIUM ALLOYS
- ZINC ALLOYS

Id	Alloy	Data Source	Condition Heat Treatment	Property Type	Environment
1817	TI-6AL-2SN-4ZR-2MO	Additional NASA Data	DA;HT/1790F/1HR;AC;HT/1100F/8HR;AC	Fatigue Crack Growth Rate (da/dN vs delta K)	AIR
1818	TI-6AL-2SN-4ZR-2MO	Additional NASA Data	DA;HT/1790F/1HR;AC;HT/1100F/8HR;AC	Fatigue Crack Growth Rate (da/dN vs delta K)	AIR
1822	WASPALOY	Additional NASA Data	DAH;ST/1875F/4HR;OQ;A	Fatigue Crack Growth Rate (da/dN vs delta K)	AIR
1897	IN-738(LC)	Additional NASA Data	DS;ST/2050F/2HR;A/1550F/24HR	Fatigue Crack Growth Rate (da/dN vs delta K)	AIR
1898	IN-738(LC)	Additional NASA Data	DS;ST/2050F/2HR;A/1550F/24HR	Fatigue Crack Growth Rate (da/dN vs delta K)	AIR
20217	ASTM A302(GRD B)	Additional NASA Data	WQ;T	Fatigue Crack Growth Rate (da/dN vs delta K)	AIR
20230	AISI 8630	Additional NASA Data	WQ;T/750F	Fatigue Crack Growth Rate (da/dN vs delta K)	AIR
20233	AISI 8630	Additional NASA Data	WQ;T/950F	Fatigue Crack Growth Rate (da/dN vs delta K)	AIR
20234	ASTM A533(TYPE B CLS 1)	Additional NASA Data	WQ;T;SR	Fatigue Crack Growth Rate (da/dN vs delta K)	AIR
20236	ASTM A533(TYPE B CLS 1)	Additional NASA Data	WQ;T;SR	Fatigue Crack Growth Rate (da/dN vs delta K)	AIR
20237	ASTM A543(TYPE A CLS 1)	Additional NASA Data	WQ;T;SR	Fatigue Crack Growth Rate (da/dN vs delta K)	AIR
20238	ASTM A543(TYPE A CLS 1)	Additional NASA Data	WQ;T;SR	Fatigue Crack Growth Rate (da/dN vs delta K)	AIR
20239	ASTM A543(TYPE A CLS 1)	Additional NASA Data	WQ;T;SR	Fatigue Crack Growth Rate (da/dN vs delta K)	AIR
19917	ZINC(3.8-4.3AL;0.03-0.06M	Additional NASA Data	UNK	Fatigue Crack Growth Rate (da/dN vs delta K)	AIR
19918	ZINC(3.8-4.3AL;0.03-0.06M	Additional NASA Data	UNK	Fatigue Crack Growth Rate (da/dN vs delta K)	AIR

Page size: 15

342 items in 23 pages

Search Options

- Material
- Product
- Specimen
- Reference
- Test Profile

Start Search from Product

AF Mat > Product

Product

X >> Form Is Sheet

and Form Is Sheet Add

Display Results

- ALLOY STEELS
- Aluminum
- BERYLLIUM/BERYLLIUM ALLOYS
- COPPER/COPPER ALLOYS
 - C10100(PURE)
 - C10200
- MANGNESIUM ALLOYS
- MOLYBDENUM/MOLYBDENUM ALLOYS
- NICKEL BASED SUPER ALLOYS
- STAINLESS STEELS
- TITANIUM ALLOYS

Id	Form	Thickness
10	Sheet	
11	Sheet	0
12	Sheet	0.01
13	Sheet	0.02
14	Sheet	0.024
15	Sheet	0.025
16	Sheet	0.026
17	Sheet	0.03
18	Sheet	0.032
19	Sheet	0.036
20	Sheet	0.039
21	Sheet	0.04
22	Sheet	0.05
23	Sheet	0.052
24	Sheet	0.06

Page size: 15

54 items in 4 pages

Start Search from Specimen

AF Mat > Specimen

Specimen

X >> Orientation Is L-T

and Orientation Is UNKNOWN Add

Display Results

- ALLOY STEELS
- Aluminum
- BERYLLIUM/BERYLLIUM ALLOYS
- COPPER/COPPER ALLOYS
- MANGNESIUM ALLOYS
- NICKEL BASED SUPER ALLOYS
- STAINLESS STEELS
- TITANIUM ALLOYS

Id	Type	Orientation	Width	Thickness
6063	3-Point Notched Bend (3-NB)	L-T		1.379
6749	Part Through Surface Crack (PTSC) (Max Load Specified)	L-T		0.374
5333	Center Cracked Panel (CCP) (Max Load Specified)	L-T		0.615
407	Compact Tension (CT)	L-T		0.06488
703	Compact Tension (CT)	L-T		0.349
1884	Compact Tension (CT)	L-T		1.5
5138	Center Cracked Panel (CCP) (Max Load Specified)	L-T		0.204
4905	Center Cracked Panel (CCP) (Max Load Specified)	L-T		0.081
5221	Center Cracked Panel (CCP) (Max Load Specified)	L-T		0.253
1056	Compact Tension (CT)	L-T		0.748
5871	Center Cracked Panel (CCP) (Max Stress Specified)	L-T		0.368
1388	Compact Tension (CT)	L-T		0.998
1861	Compact Tension (CT)	L-T		1.5
1576	Compact Tension (CT)	L-T		1.243
449	Compact Tension (CT)	L-T		0.105

Page size: 15

3837 items in 256 pages

Search by Reference

Reference Data

X >> Title Contains A

and Title Is Add

Display Results

Reference	Title	Authors	Number	Reporting Date
swri066335	Plastic Media Blasting Material Characterization Study for Use on Thin Skinned Substrates	FitzGerald, J. H., Sharron, T. R., Spigel, B. S., Whitney, T. G., Buckingham, J. P.		July 1995
ad-a276-926	Fatigue Testing of 2024-T3 Material After Four Cycles of PMB Stripping	Muller, M.; Chen, C. C. T.	DOT/FAA/CT-93/43	November 1993
74720	The Use of Deformation Voids to Refine the Austenitic Grain Size and Improve the Mechanical Properties of AFC-77	Webster, D.	Report D6-23870	February 1969
76136	The Stress Corrosion Resistance and Fatigue Crack Growth Rate of High Strength Martensitic Stainless Steel, AFC 77	Webster, D.	Report D6-23973	June 1969
77934	Evaluation of Carpenter Custom 455	Uchida, J. M.	Report D6-23928	November 18, 1969
80685	Optimization of Strength and Toughness in Two High Strength Stainless Steels	Webster, D.		July 1971
83613	The Resistance of Some High Strength Steels to Slow Crack Growth in Salt Water	Sandoz, G.	Report 2454	February 1972
84212	Fracture Toughness Tests, Data on Armco 17-4PH and 15-5 PH Alloys	Takacs, E.G.		October 18, 1972
84302	Increasing the Toughness of Martensitic Stainless Steel AFC 77 By Control of Retained Austenite Content, Ausforming and Strain Aging	Webster, D.		December 1968
84306	B-1 Fracture Mechanics Data for Air Force HandBook Usage	Harrigan, M. J.	Report TFD-72-501	April 21, 1972
84333	Stress Corrosion Properties of High Strength Precipitation Hardening Stainless Steels	Carter, C. S.; Farwick, D. G.; Ross, A. M.; Uchida, J.M.		May 1971
84365	Plane Strain Fracture Toughness - PH 13-8 Mo	Takacs, E. G.		July 11, 1972
85034	Laboratory Reports on Fracture Toughness Tests	Mitchell, John		February 5, 1973
85544	Dynamic and Static Embrittlement of a High Strength Steel in Water	Speidel, M. O.		
85836	B-1 Fracture Toughness Data (K sub(lc)) - Rockwell International			April 24, 1973

Test Profile Information

Test Profile - Windows Internet Explorer
http://www.afgrow.net/afmat/UpdateTestProfile.aspx?id=5902

AFGROW | AFMAT
Crack Growth Database

Home Product Reference Specimen Test Profile

AF Mat > Test Profile > View Test Profile

Test Profile

Materials

- ALLOY STEELS
- Aluminum
- BERYLLIUM/BERYLLIUM ALLOYS
- BRASS
- BRONZE
- COPPER/COPPER ALLOYS
- IRON ALLOYS
- MANGNESIUM ALLOYS
- MOLYBDENUM/MOLYBDENUM ALLOYS
- NICKEL BASED SUPER ALLOYS
- NIOBIUM/NIOBIUM ALLOYS
- SOLDERS
- STAINLESS STEELS
- TITANIUM ALLOYS
 - BETA 21S
 - BETA C
 - BETA III TI
 - CORONA 5
 - IMI 130 CP (LOW O2)

General Specimen Reference Product Test and Data Plot

Basic Information

Data Source:	AIR FORCE		
Property Type:	Fatigue Crack Growth Rate (da/dN vs delta K)		
Alloy:	TI-6AL-4V		
Environment:	LAB AIR		
Date:	1982	Heat Nbr:	P5432
Humidity:	105		
KicI:		KicH:	
Rcl:		Rch:	
Strength:		Temperature:	600
Ysh:		Ysl:	

Done Internet | Protected Mode: On 100%

Future Development

- Web services interface (will enable desktop applications to view data)
- Save search results
- Save test profile to my favorites
- Add more data
- Add processed data (data that could be input to crack growth analysis software)