



BERKELEY LAB
LAWRENCE BERKELEY NATIONAL LABORATORY



Carbon Fiber Laminate Theory (Laminated Plate Theory)

LBNL Composites Workshop
February 29-March 3, 2016

Overview

What are composites and why we use them

Very brief introduction to design estimation

Design resources (under construction)

Q&A

For this discussion: ‘Carbon Fiber’ as a material, is Carbon Fiber Reinforced Plastic (CFRP)—a ‘Composite’. Composites with other fibers and matrices are also broadly mentioned.

Design Resources



Home

- R&D Projects
- Composites DB
- Composites DB Prototype
- Design Resources
- Administration
- Log Out

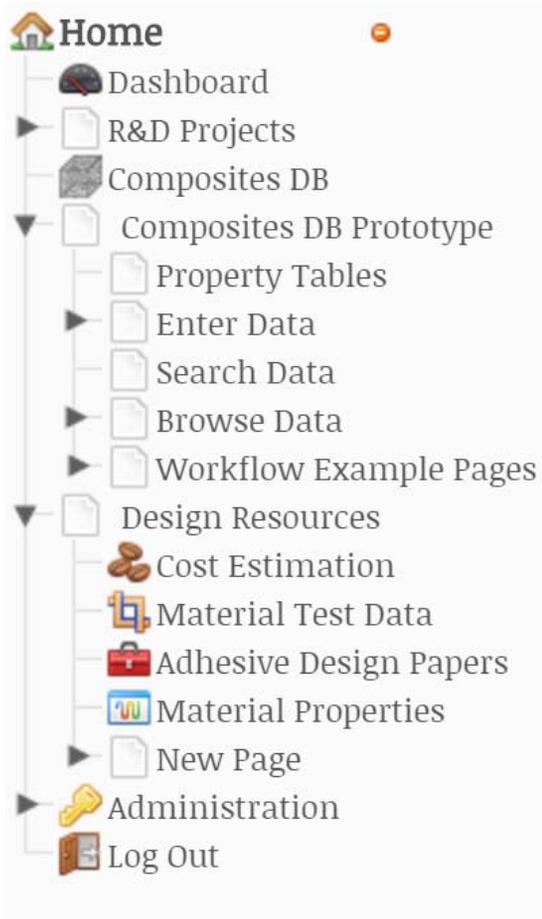
Composites Engineering

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Presently internal resource at LBNL—looking to share outside—will post most resources to this indico page

<https://composites.lbl.gov> (requires LDAP login)

Composites.lbl.gov



This is the Composites CMS--parts can be made publicly accessible

Can control/limit proprietary docs separately

Need to take care about external folk posting (reading OK)

Can have 'blind' upload capability to filter out Copyright docs etc...

'Cost Estimation' includes old quotations—unsure if these are proprietary or not...

Composites QA Database

The screenshot shows the LBNL Composites Tracking web application. At the top, there is a header with the Berkeley Lab logo and the text "LBNL COMPOSITES TRACKING". Below the header, there is a "Menu" on the left side and an "Index Page" on the right. The "Menu" includes sections for "Composites Tracking" (with sub-items: Materials, Batch, Rolls/Kits, Mass In-Out Entry, Part Type, Parts, Assembly Types, Assemblies, Improvement Requests, Administration, Log Out) and "Data Browser" (with sub-items: Materials, Parts, Assemblies). The "Index Page" features a large heading "Welcome to the Composite Database Accounting System" and a central image of a large industrial oven. Below the oven image are three icons: a question mark labeled "What's This?", a balance scale labeled "Mass In/Out", and a pair of scissors labeled "Cut Kit". At the bottom right of the page, it says "Page generated in 0.39085 seconds".

Mainly used to track outlife now—built on old computing infrastructure

Menu

- Composites Tracking
 - Materials
 - Batch
 - Rolls/Kits
 - Mass In-Out Entry
 - Part Type
 - Parts
 - Assembly Types
 - Assemblies
 - Improvement Requests
 - Administration
 - Log Out

Data Browser

- Materials
 - Fiber: AQII Weave: UDT
 - Fiber: CN60 Weave: UDT
 - Fiber: YSH80A Weave: UDT
 - Fiber: CN60 Weave: PW
 - Fiber: None Weave: Film
 - Fiber: Glass Weave: NW
 - Fiber: P30 Weave: PW
 - Fiber: Glass Weave: NW
 - Fiber: Heater Panel Weave: NA
 - Fiber: M60J Weave: NW
 - Fiber: K13D2U Weave: UDT
 - Fiber: M50J Weave: UDT
 - Fiber: M55J Weave: UDT
 - Fiber: M46J Weave: UDT
 - Fiber: CN60 Weave: PW
 - Fiber: K13D2U Weave: UDT
 - Fiber: K13C2U Weave: UDT
 - Fiber: Kapton Cable Weave: N/A
 - Fiber: test Weave: test
- Parts
 - Part Name: Flange Base Drawing:
 - Part ID: 100170
 - Ply ID: 100197
 - Part ID: 100380

Detail View Ply Metadata

Record ID #: 100197

Ply Mass Pre Layup: 122.66

Part Reference: 100170

Layer Number: 1

Material Reference: 100142

Ref Out Time ID: 1062067961

Able to trace Plies in part to material reference

Components of the DB are breaking, for example ref-out time used to count in days/hours, show material ref name, etc.

Looking to Update in coming years to be more user friendly...

Useful for Data Browsing, but need to improve data integrity (spelling, data entry order, etc.)

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 - Fiber: CN60 Weave: PW
 - Fiber: None Weave: Film
 - Fiber: Glass Weave: NW
 - Fiber: P30 Weave: PW
 - Fiber: Glass Weave: NW
 - Fiber: Heater Panel Weave: NA
 - Fiber: M60J Weave: NW
 - Batch ID: 14 Date: 01/22/2004
 - 100824
 - 101939
 - Fiber: K13D2U Weave: UDT
 - Fiber: M50J Weave: UDT
 - Fiber: M55J Weave: UDT
 - Fiber: M46J Weave: UDT
 - Fiber: CN60 Weave: PW
 - Fiber: K13D2U Weave: UDT

Detail View Serial Batch Material

Scrap Properties 

This material (#100824) has EXPIRED.

Record ID #: 100824
 Batch ID#: [14](#)
 Original Measured Mass: 2.565 kg
 Original Material Mass: 0.228 kg
 Original Out Time: 2 hours
 Chemical DB Number:
 Current Mass: 2.440 kg
 Current Material Mass: 0.103 kg
 Current Out Time: 11 hours, 20 minutes, 24 seconds
 Current Location: 77A Chest Freezer
 Current Shelf:
 Bar Code: 

Page generated in 0.11415 seconds

Material Properties

Vendor: Bryte
 Fiber Manufacturer: N/A
 Fiber: M60J
 Weave: NW
 Tow Count: N/A
 Fiber Areal Weight: 152
 Resin System: EX-1515
 Fill:
 Dry Fiber: No
 Glue: No

Batch Properties

Material Reference: [10](#)
 Backing To Material Ratio: 0
 Bleed Used For Test Panels:
 Cured Ply Thickness: 0
 Prepreg Areal Weight: 152
 Resin Ratio: 0
 Mix Ratio: 0
 Ultimate Strength:
 E1:
 E2:
 Expiration Date: 07/20/2004

Composites DB would be useful to also capture E/CPT for lamina by batch

Can easily upload documents/spreadsheets to DB

Need to add buttons ask for QA/QC data, CPT calculation spreadsheets, Tensile test data (if exists)

Each batch may have different Resin Content

Data integrity, e.g. spelling vendor name, Fiber—M55J vs M55-J—causes problems searching...

Have specification written to either re-write this DB in new infrastructure, and/or fix this

We can distribute the spec, under negotiation so see if a re-written DB can be distributable.

Advanced Light Source

ALS ENGINEERING
LAWRENCE BERKELEY NATIONAL LABORATORY

U.S. DEPARTMENT OF ENERGY

A-Z INDEX | PHONE BOOK | CAREERS | SEARCH

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- OUTBOX (world)
- OUTBOX (LBNL only)
- Engineering Reviews
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 - Documents on Standa
 - Material Properties
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 - ANSYS Workbench Cus
 - Seismic and Anchorin
 - LBNL Design Data 1946
- Reference Books
 - X-Ray Data Booklet
 - Hilti Floor Anchors
 - Parker O-ring Handbo
 - CoorsTek Ceramics
 - Sorbothane
 - MIL Handbook 17
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Providing mechanical engineering support to the Advanced Light Source

[LBNL Home](#) - [ALS Home](#) - [LBNL Engineering](#)

Similar CMS to Composites—limited to intranet due to some proprietary information

Used to Store material library and datasheets

Material Properties Collected (isotropic)

Material Property Library

Reference: **Engineering Note 10584**

- Download XML file to a local file location on your computer.
- Point to the XML file as a Data Source in ANSYS Workbench.
- To update, add, or make corrections:
 - Let Ken Chow know you want to make edits
 - Save a new file with your changes and send the file to Ken
 - Update the revision history text file and send it to Ken
 - Changes will be vetted and a new version uploaded to this site
- To extract material property data from XML file, use Excel or other XML editor/reader

Notes:

- 1) 00064-ME02-I_matprops.xls is an old materials database used by the SNAP project
- 2) ALS_Materials_OLD.xls is an old materials Excel file from Frederic Gicquel
- 3) ALS_Materials_2011_08_09.xls is the same as (2) above but with values confirmed to be from MPDBv5.62, and with a few extra materials.
- 4) MPDB is a third-party materials properties database program. Contact Ken Chow for more information.

Material under control in
CMS—approval informal,
but data centralized

Icon	File Name	Last Modified
	ALS Materials 2011 08 09.xlsx	Aug 09, 2011 12:18:03 pm
	00064-ME02-I_matprops.xls	Sep 28, 2010 11:53:16 am
	ALS Materials OLD.xls	Sep 28, 2010 11:53:16 am
	EngNote10584A_material_library.docx	Aug 09, 2011 12:12:39 pm
	ALS ANSYS Materials 2011 08 09.xml	Aug 09, 2011 12:44:49 pm
	lib_rev_notes_2011_08_09.txt	Aug 09, 2011 12:43:05 pm
	ALS ANSYS Materials 2011 03 10.xml	Aug 09, 2011 12:00:59 pm
	lib_rev_notes_2011_03_10.txt	Mar 10, 2011 03:49:20 pm

Download All

ALS (Advanced Light Source) Material Properties Database

A	B	C	D	E	F	G	H	I	J	K
1	AlBeMet162	MPDB	MPDB	MPDB	MPDB	MPDB	MPDB	MPDB	MPDB	MPDB
2	Temp (K)	CTE	Young's Modulus	Poisson ratio	Thermal Conductivity	Specific Heat	density	Tensile Yield Strength	Ultimate tensile strength	electrical resistivity
3	units	(K ⁻¹)	(Pa)		(W m ⁻¹ K ⁻¹)	(J kg ⁻¹ K ⁻¹)	(kg m ⁻³)	(Pa)	(Pa)	(ohm-m)
4		-6.84		DNE		DNE				DNE
5		13.16								
6		33.16	1.82499E+11					400258075	496382771	
7		53.16	1.8245E+11					369523677	472986606	
8		73.16	1.82402E+11					347010737	453312732	
9		93.16	1.82353E+11					338763602	437002545	
10		113.16	1.82304E+11					333473472	423697444	
11		133.16	1.82255E+11					328862636	413038824	
12		153.16	1.82207E+11		330.673598			324931093	404668083	
13		173.16	1.82158E+11		310.6444944			321678843	398226618	
14		193.16	1.82109E+11		292.2617261			319105886	393355825	
15		213.16	1.24321E-05	1.82061E+11	275.4887254		2076.492	317212222	389697103	
16		233.16	1.26921E-05	1.82012E+11	260.2806102		2075	315997852	386891847	
17		253.16	1.29521E-05	1.81963E+11	246.5841842		2073.445	315462774	384581454	
18		273.16	1.32121E-05	1.81914E+11	234.3379367		2071.828	315606990	382407323	
19		293.16	1.34721E-05	1.81866E+11	223.4720426		2070.148	316430499	380010849	
20		300	0.000013561	1.81849E+11	220.0589195			2069.56		
21		313.16	1.37321E-05	1.81817E+11	213.9083626			2068.407		
22		326	0.000013899	1.81786E+11	208.4150687			2067.256		
23		333.16	1.39921E-05	1.81768E+11	205.560443			2066.603		
24		353.16	1.42521E-05	1.81719E+11	198.333516			2064.737		
25		373.16	1.45121E-05	1.81671E+11	192.1244991			2062.809		
26		393.16	1.47721E-05	1.81622E+11	186.8219958			2060.818		
27		413.16	1.50321E-05	1.81573E+11	182.3062952			2058.766		
28		433.16	1.52921E-05	1.81524E+11	178.449372			2056.651		
29		453.16	1.55521E-05	1.81476E+11	175.1148867			2054.474		
30		473.16	1.58121E-05	1.81427E+11	172.1581853			2052.235		
31		493.16			169.4262998					
32		513.16			166.7579475					
33		533.16			163.9835316					

Material	density (kg/m ³)	k (W/(m*K))	Cp (J/(kg*K))	Thermal Ref	Yield Tensil Strength (Mpa)	Modulus (Gpa)	Poisson's Ratio	CTE (m/(m*K))	Resistivity (ohm m)	Dielectric Constant	Mechanic al Ref
at 280 K AlBeMet16	2100	210	1506	104	193	193	0.17	1.39E-05	3.50E-08		104
	2.071 g/cc	210	1.56		193	193	0.17	13.91	3.50E-08		all at temp of 293 K
			J/g-°C		as a minimum			µm/m-°C			
					from: Matweb: AlBeMeT AM 162						
					http://www.matweb.com/search/DataSheet.aspx?MatGUID=8b1dbb078c924f25a43d88496e35a586&ckck=1						

Data sources included to right of nominal Data and vetted Temperature dependant properties available (ranges vary)



Engineering Note to describe how to edit included XML Files

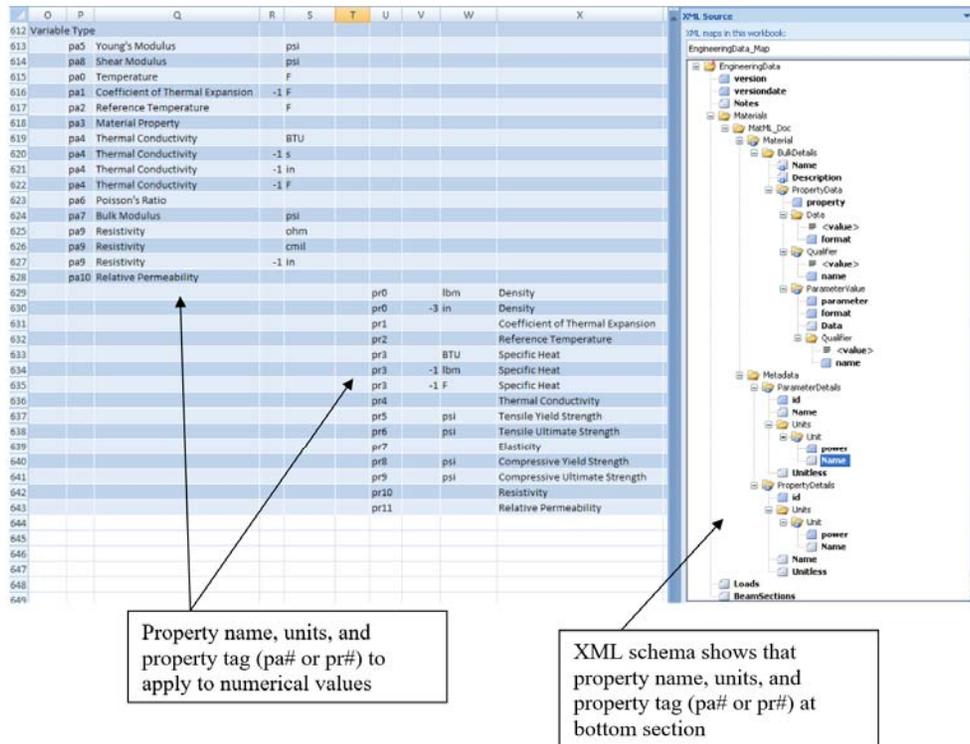


Figure 2. Using Excel to access material library data from XML file—property names and units associated with metadata tags

XML input into Workbench—custom library of materials

Centrally managed, manually applied by users

Can distribute freely

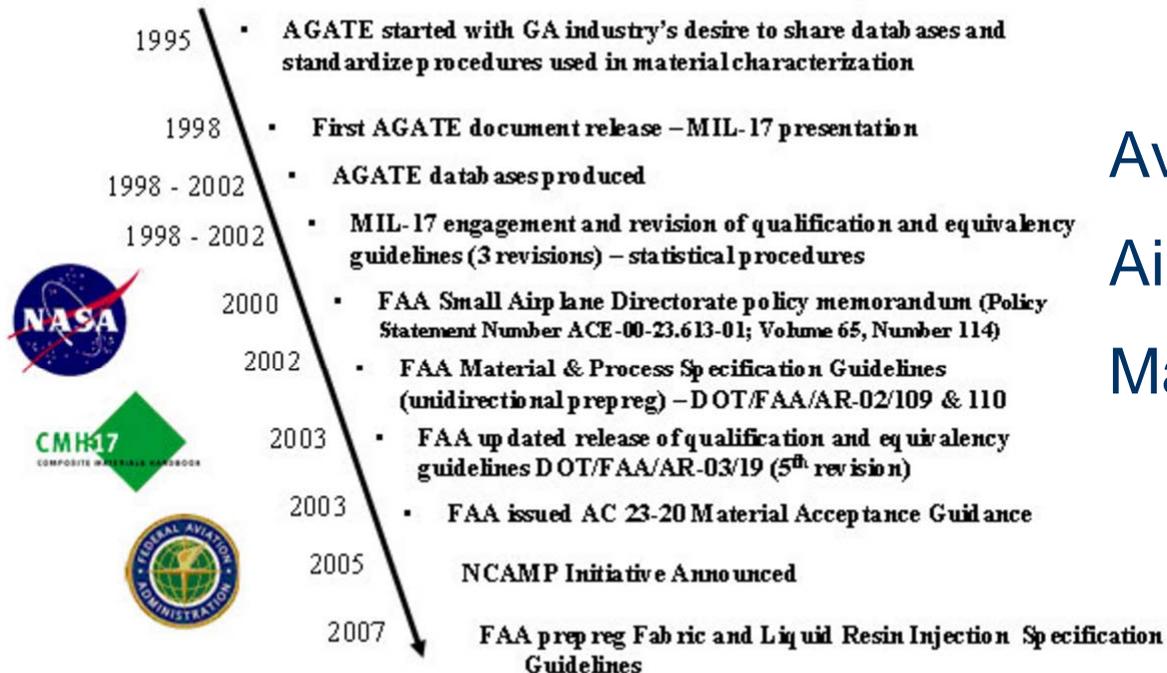
Will find good place to Circulate

Would like to do similar for ACP...

AGATE Database

<http://www.niar.wichita.edu/agate/>

Timeline of Activity



Data available online—also in MIL-HDBK-17-2F...

Available in pdf, but not xml

Aimed at general aviation

May include up to UHM (M55-60J etc)

Concluding remarks

Clearly need to find a good location to collect data

Good if all can access and ‘manage’, but may still need administration or curation...

Perhaps the organizers of this conference (and future) can take lead

Hosting at CERN may be option, but need credentials—currently has no great CMS, but does have many...

All have same problem—discussion welcome.