WARP: A Centralized Repository for Physics-Based Models

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2012 Physics-Based Modeling in Design and Development for U.S. Defense

Outline

- Introduction
- WARP Objective and Concept
- WARP Tasking
- WARP Database Record Types
- Features of the WARP Website
- Current Status/Future Work
- Contact Information

Introduction

- Current Trend in Reliability is Towards Physics-Based Approaches to Design for Reliability (DFR)
- No Centralized Repository for Physics-of-Failure Models
- PoF Models Have Received Limited Exposure and Acceptance Despite Greater Recognition of Value
- RIAC Funded by Defense Technical Information Center (DTIC) to Develop the Web-Accessible Repository of Physics-Based Models (WARP)
  - Effort was completed in May 2012
  - Quanterion Solutions Incorporated (Model Research/Database Development/Website Development)
  - University of Maryland Center for Risk and Reliability (Model Research)

WARP Objective and Concept

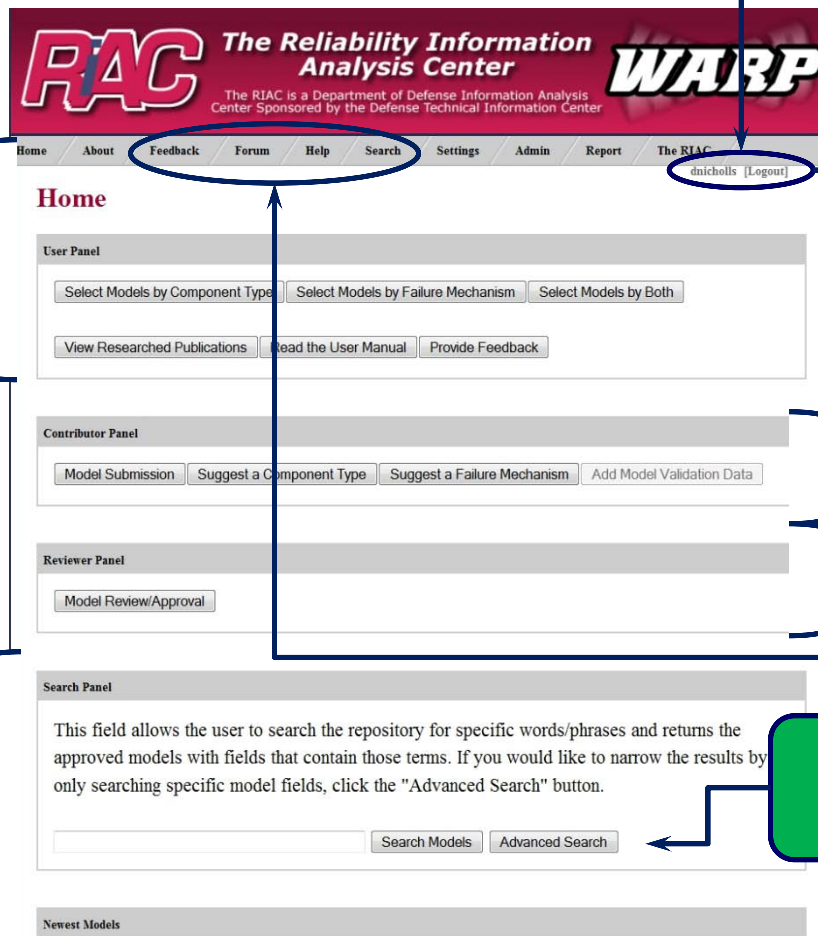
- Collect, Analyze and Catalog the Existence and Characteristics of PoF Models
- Provide a Centralized Web-based Repository of PoF Models for Researchers and Engineers
- Promote Understanding of:
  - What PoF models are needed to fully characterize component reliability (major failure mechanisms, including package-related)
  - What PoF models already exist to meet that need
  - What PoF models are missing to fill the gap (presents opportunities for research)
  - What data/information is required to exercise a specific model
  - Where can the required data/information be obtained

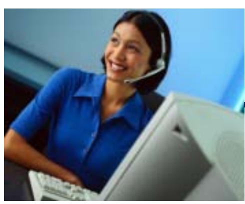
WARP Objective and Concept

Web-Based PoF Model Submittal or "Model Needed" Request

Model Info Submittal or Request Requires Member Registration & Login

RIAC Confirms WARP Membership and Reviews PoF Model Source Document Before Approving





Web-Based PoF Model User *(no member registration or login required)*

Additional Area Accessible Only to WARP Model Contributing Members

Additional Area Accessible Only to RIAC Administrators

Establishes separate Search, Forum, Help and Feedback Areas for Users / Members

WARP Objective and Concept

- Rules for <u>Submitting</u> PoF Models to WARP
  - Submitted information based on source document "facts"
  - No copyright violations
  - Editorial comments on a specific model restricted to WARP Forum (monitored by RIAC)
  - Editorial comments must be accompanied by supporting rationale and/or data/documentation
- Rules for <u>Suggesting</u> PoF Models
  - PoF model does not appear in WARP or the literature
    - Represents a "gap" in the PoF Model domain (research opportunity)
  - Associated component/technology types must be identified

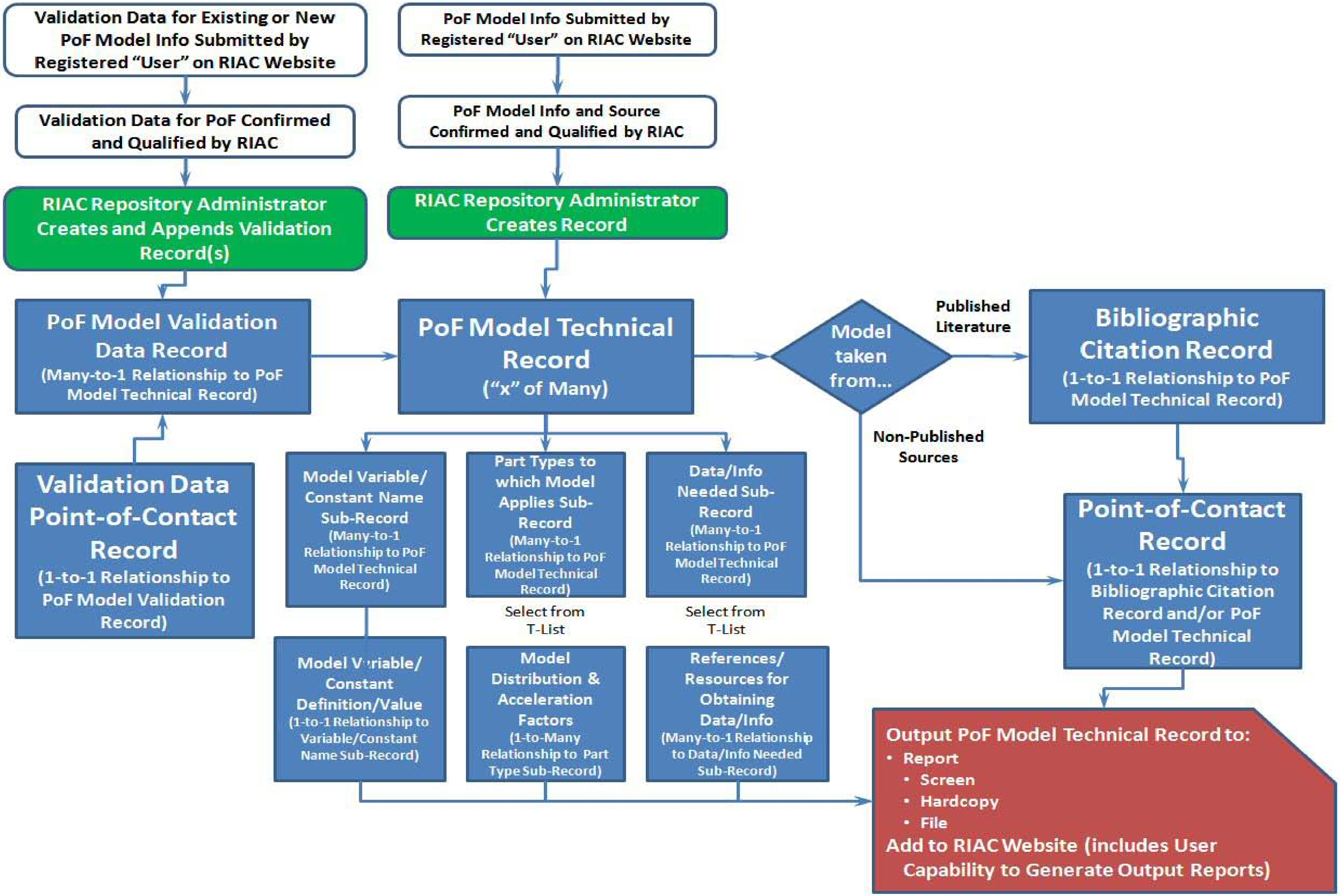
WARP Development Process

- Develop Taxonomy of Component/Technology Types to which PoF Models Should Apply
  - Based on Draft MIL-HDBK-217G and RIAC NPRD publication
- Research and Collect Failure Mechanism Models
  - Over 150 resources were evaluated as potential PoF model sources (published literature, RIAC/UMD/DTIC libraries, research reports, etc.)
- Develop Database and Website

WARP Database Record Types

- Four Major Types
  - PoF Failure Mechanism Model Technical Record
  - Bibliographic Citation Record
  - Point-of-Contact Records:
    - For obtaining copy of document
    - For contacting the model developer
    - For contacting the person submitting validation data
  - Model Validation Record

WARP Database Record Types



Overview of WARP PoF Model Record

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PoF Model Title

Analysis of the Effects of Compressive Stresses on Fatigue Crack Propagation Rate

Primary Model Image

Model Image

$$da/dN = C[1-\gamma(\sigma_{maxcom}/\sigma_{ys})]^{\beta}(K_{max})^{2(\alpha+\beta+1)}$$

(Click on image to see full size version)

Model Tree (Submodels)

Model Tree Diagram

Analysis of the Effects of Compressive Stresses on Fatigue Crack Propagation Rate
- Parameter: β
- Parameter: K_{max}
  - Parameter: β
- Parameter: C
  - Parameter: β

Primary Model Parameters

Model Parameters

Name	Description	Parameter Type	Value	Units	View Sub-Model
da/dN	Fatigue crack propogation rate	Variable		meters per cycle	
C	Material constant	SubModel/Equation			View
γ	Bauschinger effect parameter	Constant (Material Prop.)	overaged 7049 Al Alloy: 50, underaged 7049 Al Alloy: 30	Not Specified	
σ_{maxcom}	Maximum compressive stress level of the stress cycle	Variable		Not Specified	
σ_{ys}	Material yield stress	Constant (Material Prop.)		Not Specified	
β	Constant	SubModel/Equation			View
K_{max}	Maximum stress intensity factor corresponding to the maximum applied stress	SubModel/Equation			View
α	Constant	Constant	Overaged 7049 Al Alloy: 0.515, Underaged 7049	Dimensionless	

Overview of WARP PoF Model Record

Failure Mechanism Addressed by Model

Failure Mechanism

Name
Fatigue

Component / Technology Types

Name
Metallic Materials

Component/ Technology Addressed by Model

Characteristics

Title	Description
Effect of Compressive Stresses	This model was developed to more accurately account for the effect of compressive stresses on fatigue crack growth; specifically for constant amplitude loading when the stress ratio (R) is less than 0. The effects are due to the continuous increase of the size of the reverse plastic zone with the increase of the applied compressive stress.
Finite Element Analysis	FEA was used in this study to understand the change of near crack tip opening displacement and the plasticity around the crack tip under tension-compression loading. The analysis considered a center crack panel (CCP) specimen with a crack length of 2mm. The applied stress ratio (R) was -1.
Maximum Reverse Plastic Zone Size	Under tension-compression loading and small scale yielding, the maximum reverse plastic zone size (a parameter affecting crack growth) can be expressed as a function of the maximum stress intensity factor (Kmax), and the maximum applied compressive stress (sigma maxcom).
Bauschinger Effect	For materials with strong anisotropic hardening or softening behavior, the Bauschinger Effect is the most important plastic cyclic property in terms of negative loading effect on fatigue crack growth. It strongly influences the reverse plasticity and near crack tip opening displacement. It's influence is reflected by parameter gamma of this model.
Kmax for R<0	The maximum stress intensity factor (Kmax) for tension-compression constant amplitude loading with stress ratio R<0 is determined from a modification to Kmax for R=0 constant amplitude loading.
Parameters α and β	Parameters α and β can be calculated from two positive constant amplitude loading fatigue crack propagation test results. However, as these aren't always available, a previous reference developed the following relationships to determine the values of these two parameters. β=2α, and 2(β+α+1)= m, where m represents the exponential constant in Paris' crack growth law.

Characteristics of Model Development (as Described in Source Document)

Overview of WARP PoF Model Record

Model Assumptions, Limitations, Constraints and Uncertainty Limits (as described in Source Document)

Assumptions

Title	Description
N/A	N/A

Limitations

Title	Description
R<0	This model was developed only for fatigue scenarios with a negative stress ratio (R).
Model Constants	Values for the model constants (notably, α and β) are specific to the materials used in this study. When considering other materials, testing will likely be required to determine the appropriate values for such parameters.

Constraints

Title	Description
N/A	N/A

Uncertainty Limits

Type	Uncertainty
N/A	N/A

Data/Information Needed to Exercise the Model

Data or Information Needed from Outside Sources

Category	Source	Description
Scaling Factor	User	Model constant (B), testing required
Mechanical Properties	User	Bauschinger effect parameter (γ), may require testing
Mechanical Properties	User	Max stress intensity factor for constant amplitude loading where R=0 $[(K_{max})_{R=0}]$

Overview of WARP PoF Model Record

Bibliographic Citation

Published Status	Source Type	Title	Authors
Published	Article/Paper	Analysis of the Effects of Compressive Stresses on Fatigue Crack Propagation Rate	J. Zhang, S. Y Du, X. D He

Abstract/Summary

In this study, the effects of compressive stresses on the crack tip parameters and its implication on fatigue crack growth have been studied. Elastic–plastic finite element analysis has been used to analyse the change of crack tip parameters with the increase of the applied compressive stress level. The near crack tip opening displacements and the reverse plastic zone size around the crack tip have been obtained. The finite element analysis shows that when unloading from peak tensile applied stress to zero applied stress, the crack tip is still kept open and the crack tip opening displacement gradually decreases further with the applied compressive stress. It has been found that for a tension–compression stress cycle these crack tip parameters are determined mainly by two loading parameters, the maximum stress intensity Kmax in the tension part of the stress cycle and the maximum compressive stress rmaxcom in the compression part of the stress cycle. Based on the two parameters, Kmax, and rmaxcom, a fatigue crack propagation model for negative R ratios only has been developed to include the compressive stress effect on the fatigue crack propagation rate. Experimental fatigue crack propagation data sets were used for the verification of this model, good agreements have been obtained.

Report #	Publication Name	Volume #	Publisher Name
N/A	International Journal of Fatigue	292007	N/A

Publication Date	Pages	Source URL	Copyright Info
2007-01-04	1751-1756	http://www.sciencedirect.com	2007 Elsevier Ltd. All rights reserved

Filename	File Description	Open File
Analysis-of-the-effects-of-compressive-stresses-on-fatigue-crack-propagation-rate_International-Journal-of-Fatigue_2007.pdf	Journal Article	Open

Technical Point of Contact (PoC)

J. Zhang
Personally Developed Model

If you would like to contact this person:

Send a message

Model Usefulness Rating

1 for not useful and 5 for very useful.

1 2 3 4 5

Rate this model

Overview of WARP PoF Model Record

Direct Link to WARP Forum for This Specific Model

Add Model Validation Data (Contributing Members Only)

Validation data can be added by the original model developer, the author, or by independent contributors

WARP Forum Comments

WARP-ADMIN
Sep 11 at 1:34 pm

This is the official thread for: Analysis of the Effects of Compressive Stresses on Fatigue Crack Propagation Rate
Please post your comments on the model here.

Add a Comment

Add Model Validation Data

Enter published or experimental data that validates the PoF Model.

Add Validation Data to Model

Disclaimer

The models and references contained herein have been compiled from the open literature and government and nongovernment technical reports and are intended to be used for reference purposes only. Neither the United States Government, Wyle Laboratories nor Quanterion Solutions Incorporated warrant the applicability and accuracy of these models. The user is further cautioned that the models and references contained herein may not be used in lieu of other contractually cited references and specifications.

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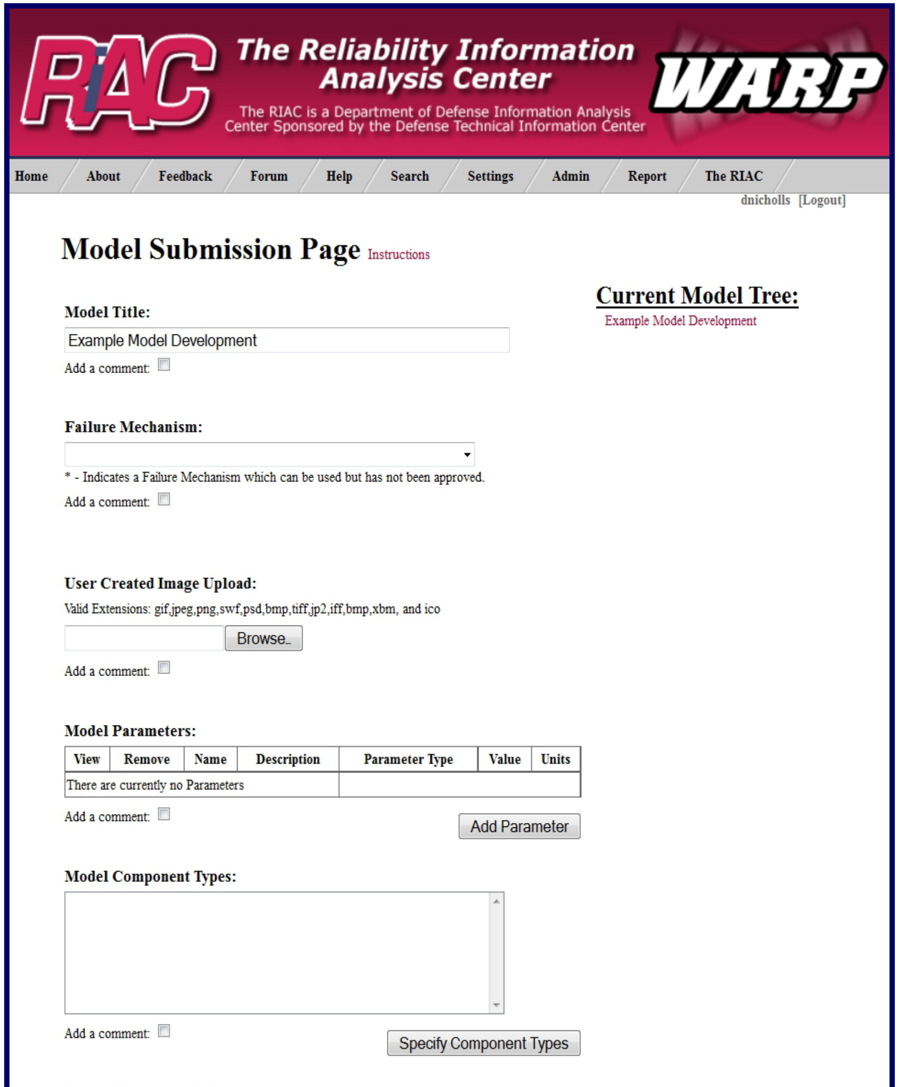
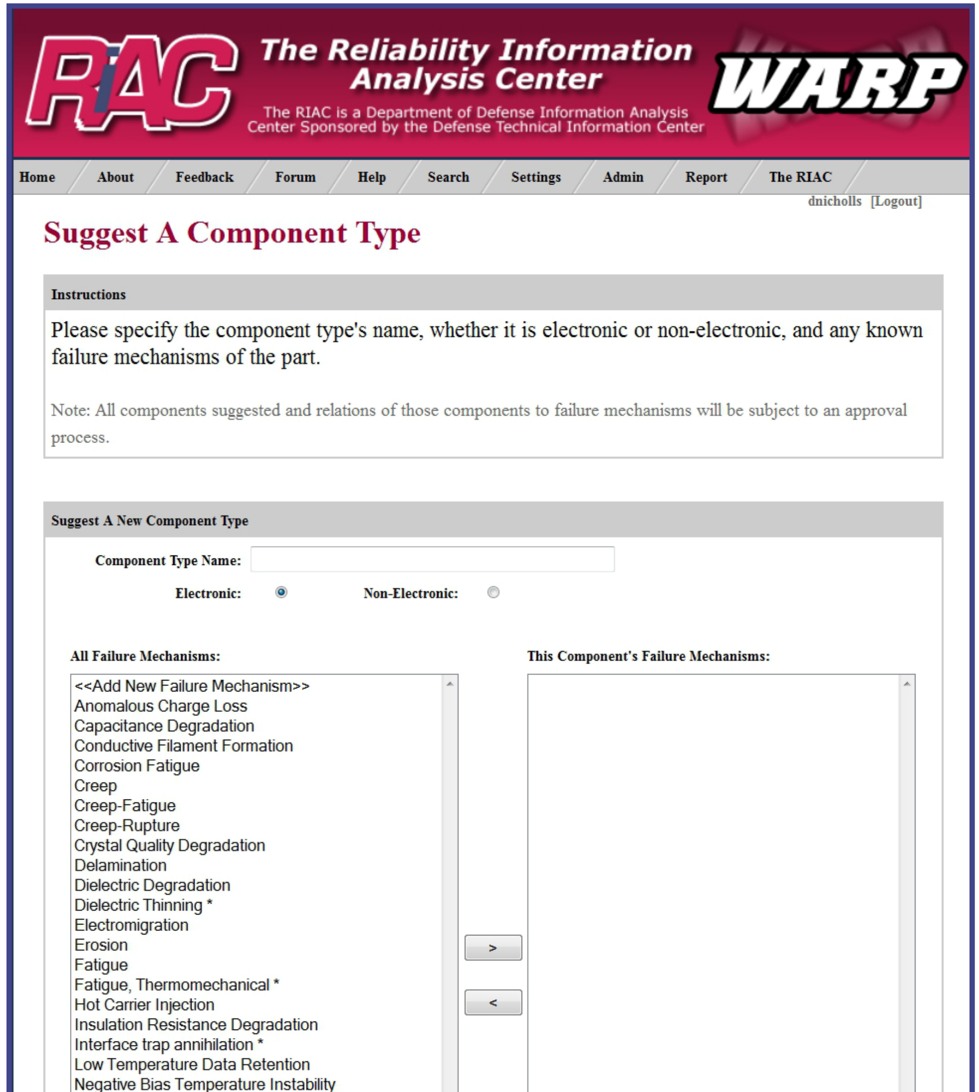
Features of the RIAC WARP Website

- Registered Members can Submit Models, Suggest Gaps Where Models are Needed, Participate in Forum
  - Forum promotes constructive discussion
  - Specific WARP Forum topic area set up to suggest “gaps”
- Select Models by Component Type or Failure Mechanism
- Search by Component/Technology Type, PoF Failure Mechanism, or any Keyword
  - General or Advanced Search
- Conceptual “Matrix” of Component/Technology Type vs. Applicable PoF Models
- Individual PoF Model Records Highlight When Data or Information is Needed from an Internal Test or an External Source (e.g., Dimensions/Properties) to Exercise the Model

Submit Models/Suggest Gaps





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Reliability Information Analysis Center Forums > RIAC WARP Forum

Comments on a Specific Model

User Name: User Name | Remember Me? | Password: | Log in

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New Thread | Page 1 of 5 | 1 | 2 | 3 | > | Last »

Threads in Forum : Comments on a Specific Model | Forum Tools | Search this Forum

Thread / Thread Starter	Rating	Last Post	Replies	Views
Analysis of the Effects of Compressive Stresses on Fatigue Crack Propagation Rate WARP-ADMIN		Today 01:34 PM by WARP-ADMIN	0	4
Deep-Trap SILC (Stress Induced Leakage Current) Model For Nominal and Weak Oxides WARP-ADMIN		09-07-2012 02:28 PM by WARP-ADMIN	0	40
Fatigue Life of 63Sn-37Pb Solder Related to Load Drop Under Uniaxial and Torsional Loading WARP-ADMIN		09-07-2012 11:18 AM by WARP-ADMIN	0	10
Chip Scale Package (CSP) Solder Joint Reliability and Modeling WARP-ADMIN		03-23-2012 04:27 PM by WARP-ADMIN	0	1,511
Threshold Voltage Shift in 0.1 ?m Self-Aligned-Gate GaAs MESFETs Under Bias Stress WARP-ADMIN		03-22-2012 04:12 PM by WARP-ADMIN	0	562
Charge Trapping Mechanism under Dynamic Stress and its Effect on Failure Time WARP-ADMIN		03-22-2012 10:50 AM by WARP-ADMIN	0	436
Polarity-Dependent Device Degradation in SONOS Transistors Due to Gate Conduction WARP-ADMIN		01-16-2012 04:40 PM by WARP-ADMIN	0	1,417
Scintillation Breakdowns and Reliability of Solid Tantalum Capacitors WARP-ADMIN		01-16-2012 02:21 PM by WARP-ADMIN	0	526
Thin-Gate-Oxide Breakdown and CPU Failure-Rate Estimation WARP-ADMIN		01-16-2012 10:40 AM by WARP-ADMIN	0	443
Re-consideration of Influence of Silicon Wafer Surface Orientation on Gate Oxide Reliability WARP-ADMIN		01-13-2012 03:29 PM by WARP-ADMIN	0	577
Ultrathin Gate-Oxide Breakdown—Reversibility at Low Voltage WARP-ADMIN		01-13-2012 10:17 AM by WARP-ADMIN	0	604
Reliability Properties of Low-Voltage Ferroelectric Capacitors and Memory Arrays WARP-ADMIN		01-12-2012 02:04 PM by WARP-ADMIN	0	498
Statistical Modeling for Postcycling Data Retention of Split-Gate Flash Memories WARP-ADMIN		01-12-2012 10:20 AM by WARP-ADMIN	0	533
Collapse of MOSFET Drain Current After Soft Breakdown		01-11-2012 01:41 PM		

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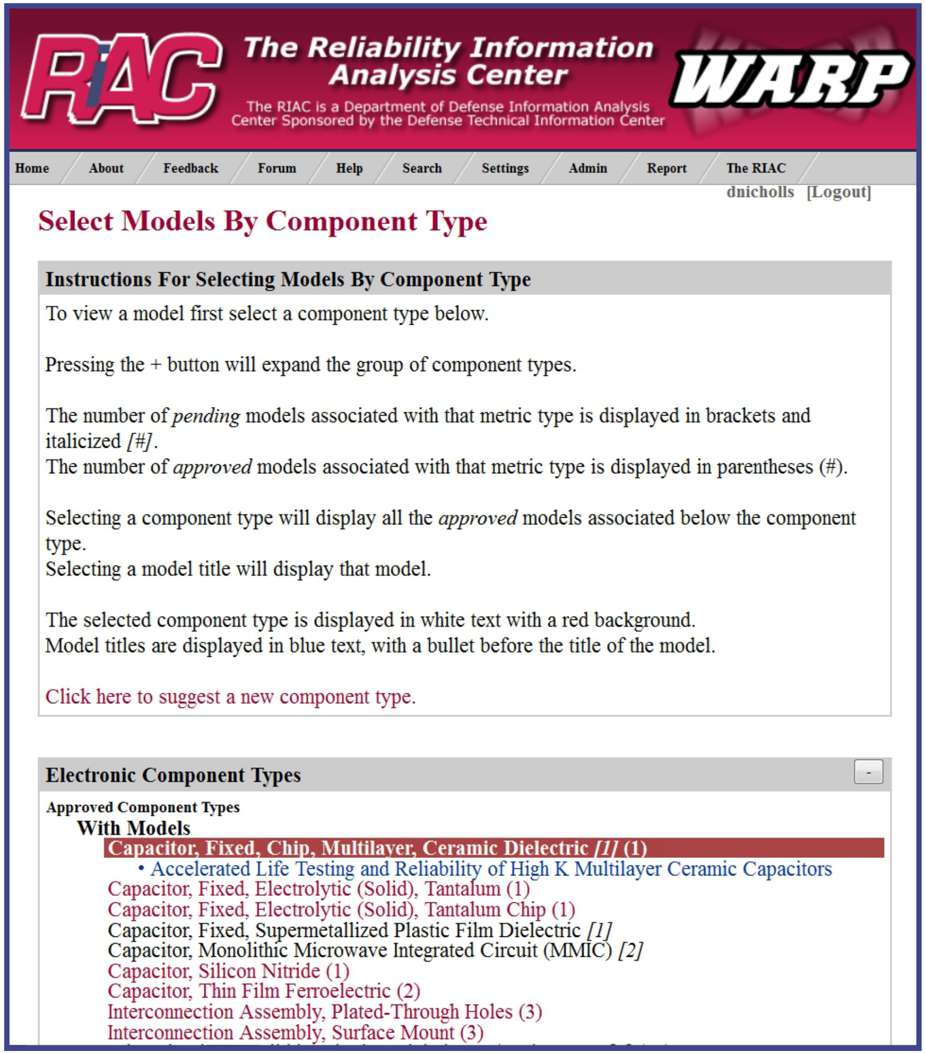
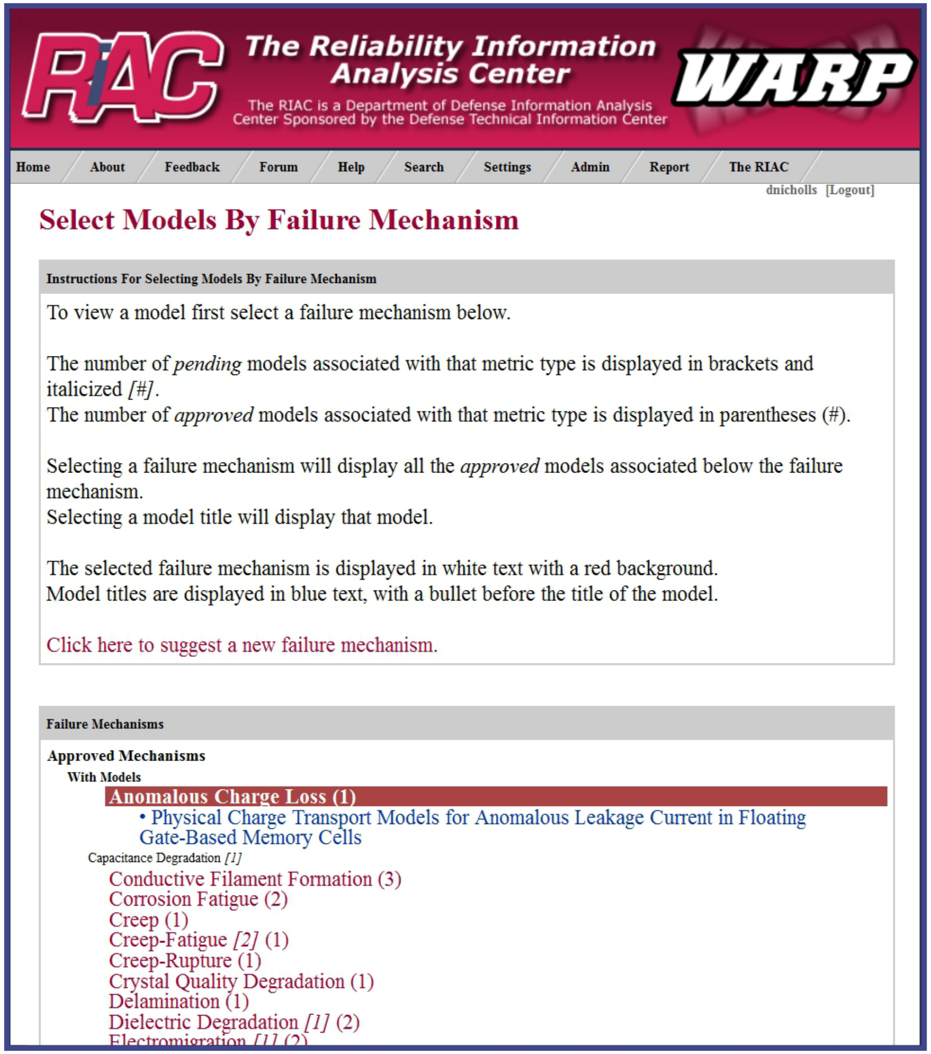
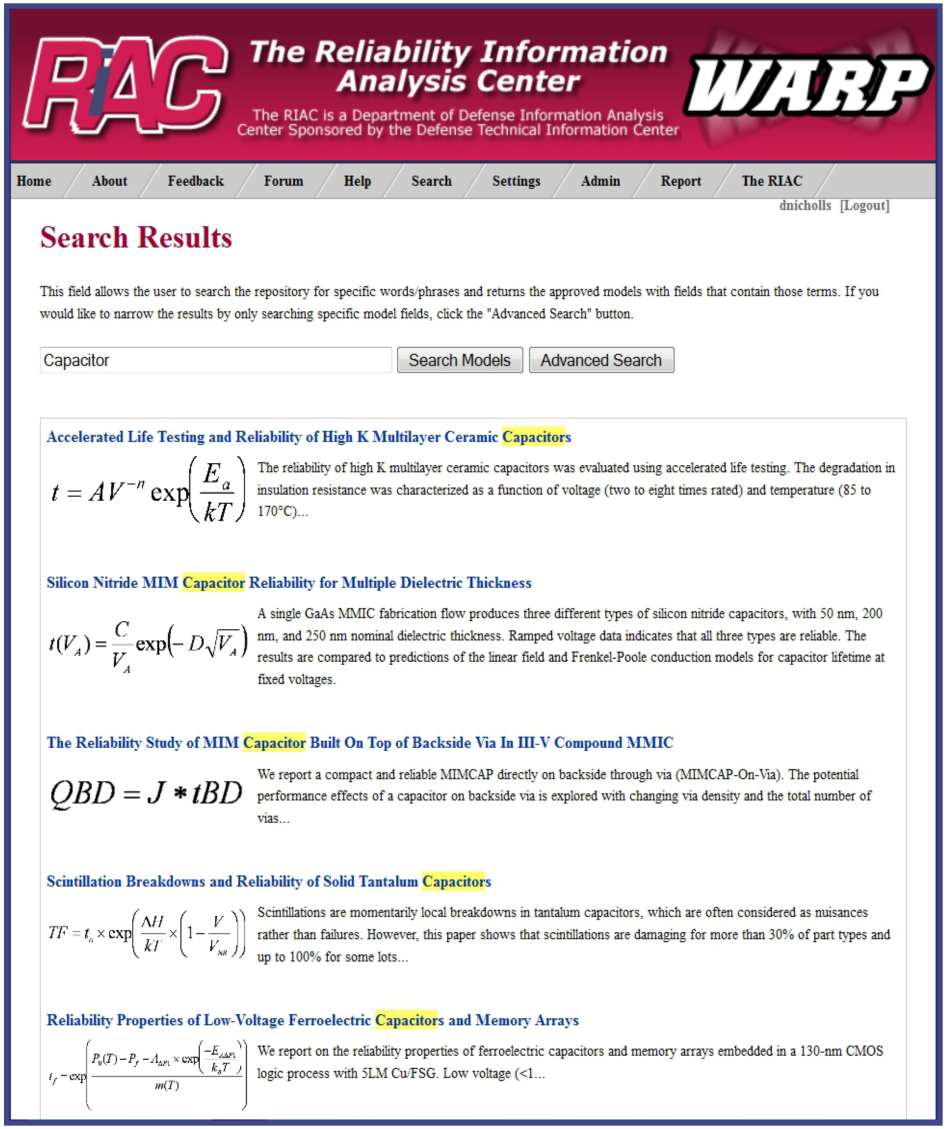
Select Models by Type or Mechanism





Search By Component or Mechanism



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Search Results

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Capacitor | Search Models | Advanced Search

Accelerated Life Testing and Reliability of High K Multilayer Ceramic Capacitors

$$t = AV^{-n}\exp\left(\frac{E_a}{kT}\right)$$

The reliability of high K multilayer ceramic capacitors was evaluated using accelerated life testing. The degradation in insulation resistance was characterized as a function of voltage (two to eight times rated) and temperature (85 to 170°C)...

Silicon Nitride MIM Capacitor Reliability for Multiple Dielectric Thickness

$$t(V_A) = \frac{C}{V_A}\exp\left(-D\sqrt{V_A}\right)$$

A single GaAs MMIC fabrication flow produces three different types of silicon nitride capacitors, with 50 nm, 200 nm, and 250 nm nominal dielectric thickness. Ramped voltage data indicates that all three types are reliable. The results are compared to predictions of the linear field and Frenkel-Poole conduction models for capacitor lifetime at fixed voltages.

The Reliability Study of MIM Capacitor Built On Top of Backside Via In III-V Compound MMIC

$$QBD = J * tBD$$

We report a compact and reliable MIMCAP directly on backside through via (MIMCAP-On-Via). The potential performance effects of a capacitor on backside via is explored with changing via density and the total number of vias...

Scintillation Breakdowns and Reliability of Solid Tantalum Capacitors

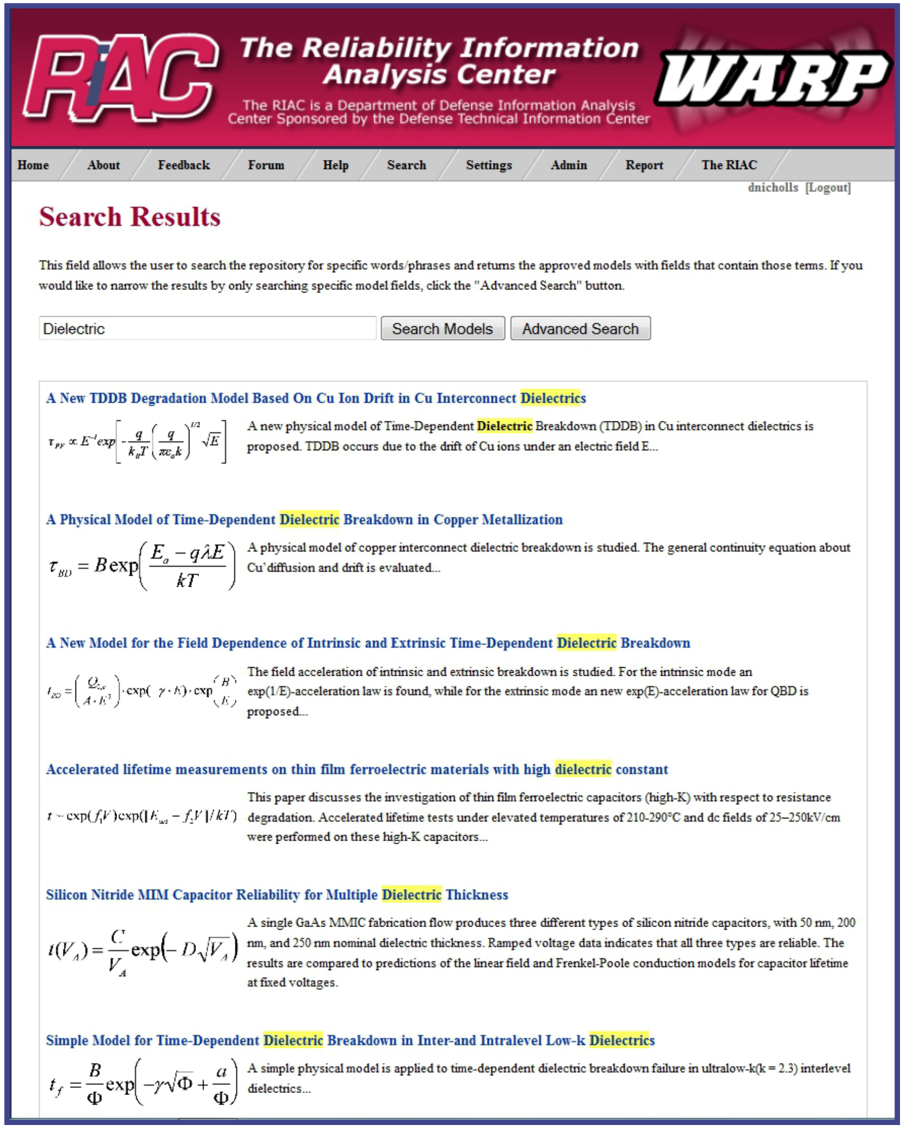
$$TF = t_a \times \exp\left(\frac{\Delta H}{kT}\times\left(1-\frac{V}{V_{NR}}\right)\right)$$

Scintillations are momentarily local breakdowns in tantalum capacitors, which are often considered as nuisances rather than failures. However, this paper shows that scintillations are damaging for more than 30% of part types and up to 100% for some lots...

Reliability Properties of Low-Voltage Ferroelectric Capacitors and Memory Arrays

$$t_f \sim \exp\left(\frac{P_0(T)-P_f-A_{\Delta Pl}\times\exp\left(\frac{-E_{\Delta Pl}}{k_bT}\right)}{m(T)}\right)$$

We report on the reliability properties of ferroelectric capacitors and memory arrays embedded in a 130-nm CMOS logic process with 5LM Cu/FSG. Low voltage (<1...



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Dielectric | Search Models | Advanced Search

A New TDDB Degradation Model Based On Cu Ion Drift in Cu Interconnect Dielectrics

$$\tau_{FF} \propto E^{-1}\exp\left[-\frac{q}{k_BT}\left(\frac{q}{\pi\varepsilon_0 k}\right)^{1/2}\sqrt{E}\right]$$

A new physical model of Time-Dependent Dielectric Breakdown (TDDB) in Cu interconnect dielectrics is proposed. TDDB occurs due to the drift of Cu ions under an electric field E...

A Physical Model of Time-Dependent Dielectric Breakdown in Copper Metallization

$$\tau_{BD} = B\exp\left(\frac{E_a - q\lambda E}{kT}\right)$$

A physical model of copper interconnect dielectric breakdown is studied. The general continuity equation about Cu' diffusion and drift is evaluated...

A New Model for the Field Dependence of Intrinsic and Extrinsic Time-Dependent Dielectric Breakdown

$$t_{BD} = \left(\frac{Q_{BD}}{A \cdot K^3}\right)\cdot\exp(\gamma \cdot K)\cdot\exp\left(\frac{B}{K}\right)$$

The field acceleration of intrinsic and extrinsic breakdown is studied. For the intrinsic mode an exp(1/E)-acceleration law is found, while for the extrinsic mode an new exp(E)-acceleration law for QBD is proposed...

Accelerated lifetime measurements on thin film ferroelectric materials with high dielectric constant

$$t \sim \exp(f_1V)\exp([E_{act} - f_2V]/kT)$$

This paper discusses the investigation of thin film ferroelectric capacitors (high-K) with respect to resistance degradation. Accelerated lifetime tests under elevated temperatures of 210-290°C and dc fields of 25–250kV/cm were performed on these high-K capacitors...

Silicon Nitride MIM Capacitor Reliability for Multiple Dielectric Thickness

$$t(V_A) = \frac{C}{V_A}\exp\left(-D\sqrt{V_A}\right)$$

A single GaAs MMIC fabrication flow produces three different types of silicon nitride capacitors, with 50 nm, 200 nm, and 250 nm nominal dielectric thickness. Ramped voltage data indicates that all three types are reliable. The results are compared to predictions of the linear field and Frenkel-Poole conduction models for capacitor lifetime at fixed voltages.

Simple Model for Time-Dependent Dielectric Breakdown in Inter-and Intralevel Low-k Dielectrics

$$t_f = \frac{B}{\Phi}\exp\left(-\gamma\sqrt{\Phi} + \frac{a}{\Phi}\right)$$

A simple physical model is applied to time-dependent dielectric breakdown failure in ultralow-k(k = 2.3) interlevel dielectrics...

Advanced Search

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Dielectric [Search Models] [Advanced Search]

Select the model fields within which you would like to search:

Titles:	☑	Abstracts:	☑
Component Types:	☑	Failure Mechanisms:	☑
Bibliographic Citations:	☑	Characteristics:	☑
Variables:	☑	Assumptions:	☑
Constraints:	☑	Limitations:	☑
Authors:	☑		
Any of the query:	○	All of the query:	◉

A New TDDB Degradation Model Based On Cu Ion Drift in Cu Interconnect Dielectrics

$$\tau_{PF} \propto E^{-1} exp\left[-\frac{q}{k_B T}\left(\frac{q}{\pi\varepsilon_o k}\right)^{1/2}\sqrt{E}\right]$$

A new physical model of Time-Dependent **Dielectric** Breakdown (TDDB) in Cu interconnect dielectrics is proposed. TDDB occurs due to the drift of Cu ions under an electric field E...

A Physical Model of Time-Dependent Dielectric Breakdown in Copper Metallization

$$\tau_{BD} = B\exp\left(\frac{E_a - q\lambda E}{kT}\right)$$

A physical model of copper interconnect dielectric breakdown is studied. The general continuity equation about Cu'diffusion and drift is evaluated...

"Matrix": Component Type vs. Mechanism

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Select Models by Failure Mechanisms and Related Components

Instructions

This page displays approved models by both the failure mechanism and component type.

The number of *approved* models associated with that component type is displayed in parentheses (#). The number of *pending* models associated with that component type is displayed in brackets and italicized *[#]*.

Selecting a component type under a failure mechanism will display all the *approved* models associated with the failure mechanism/component type combination below the component type.
Selecting a model title will display that model.

The selected component type is displayed in white text with a red background.
Model titles are displayed in blue text, with a bullet before the title of the model.

This page is sorted by failure mechanisms. Click here to sort by components.

Failure Mechanisms and Related Components

Approved Failure Mechanism

With Approved Component Types

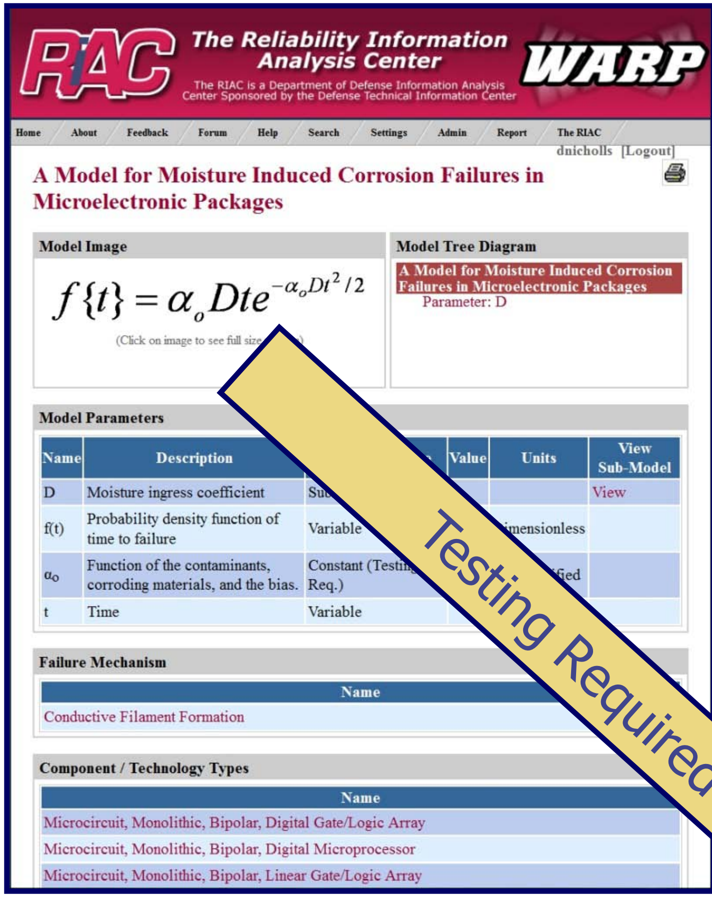
Anomalous Charge Loss

Microcircuit, Monolithic, Bipolar, Memory (1)
Microcircuit, Monolithic, MOS, Memory (1)

Capacitance Degradation

Capacitor, Fixed, Supermetallized Plastic Film Dielectric *[1]*

Required Data/Information for Models


A Model for Moisture Induced Corrosion Failures in Microelectronic Packages

Model Image

$$f\{t\} = \alpha_o D t e^{-\alpha_o D t^2 / 2}$$

Model Tree Diagram

A Model for Moisture Induced Corrosion Failures in Microelectronic Packages
Parameter: D

Model Parameters

Name	Description		Value	Units	View Sub-Model
D	Moisture ingress coefficient	Su			View
f(t)	Probability density function of time to failure	Variable		imensionless	
α_o	Function of the contaminants, corroding materials, and the bias.	Constant (Testin Req.)		fied	
t	Time	Variable			

Failure Mechanism

Name
Conductive Filament Formation

Component / Technology Types

Name
Microcircuit, Monolithic, Bipolar, Digital Gate/Logic Array
Microcircuit, Monolithic, Bipolar, Digital Microprocessor
Microcircuit, Monolithic, Bipolar, Linear Gate/Logic Array

Testing Required

Assumptions

Title	Description
Molecular Flow	Assumes that a molecular flow is the dominant mechanism of moisture ingress for leaks less than 10E-4 atm cm^3/s.
Initial Pressure	It's assumed that there is an initial partial pressure (Pin) of contaminant gas in the package.
Initial Moisture in Package	For simplicity, it is assumed that there is no initial moisture in the package.
Probability of Successful Operation	Functional dependence of the probability of successful operation [R(t)] is assumed to be linear.
Induction Time	Induction time is generally assumed to correspond to the time for condensation of three molecular layers of moisture.

Limitations

Title	Description
Metallization	The model focuses on aluminum metallization corrosion resulting from chlorine-based contaminants.

Constraints

Title	Description
N/A	N/A

Uncertainty Limits

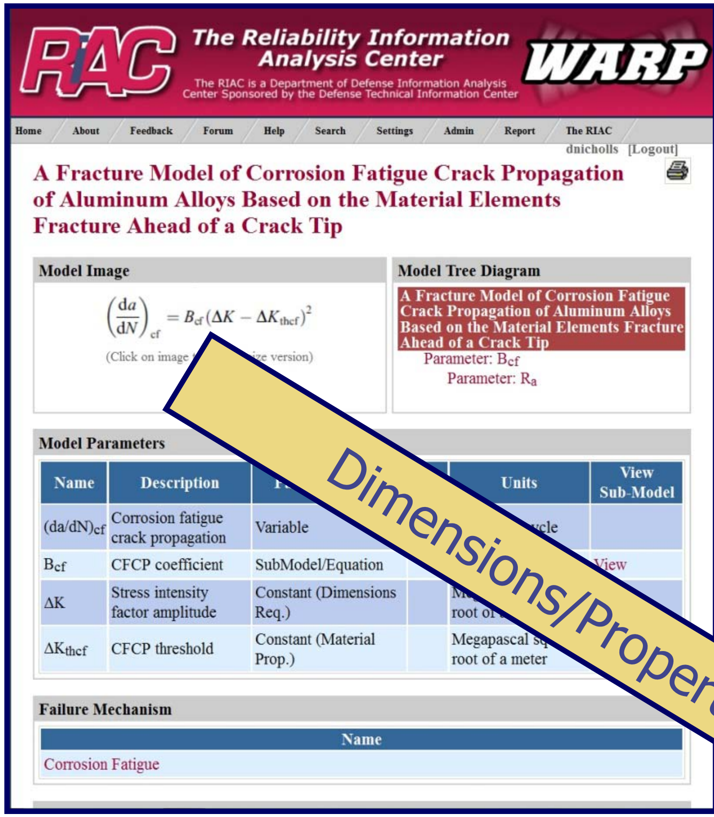
Type	Uncertainty
N/A	N/A

Data or Information Needed from Outside Sources

Category	Source	Description
Scaling Factor	User	Model constant (α_o) which is a function of the contaminants, corroding materials, and the bias; testing required.

Bibliographic Citation

Required Data/Information for Models



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A Fracture Model of Corrosion Fatigue Crack Propagation of Aluminum Alloys Based on the Material Elements Fracture Ahead of a Crack Tip

Model Image

$$\left(\frac{da}{dN}\right)_{cf} = B_{cf}(\Delta K - \Delta K_{thcf})^2$$

(Click on image ... size version)

Model Tree Diagram

A Fracture Model of Corrosion Fatigue Crack Propagation of Aluminum Alloys Based on the Material Elements Fracture Ahead of a Crack Tip

Parameter: B_{cf}

Parameter: R_a

Model Parameters

Name	Description	F...		Units	View Sub-Model
$(da/dN)_{cf}$	Corrosion fatigue crack propagation	Variable		...cle	
B_{cf}	CFCP coefficient	SubModel/Equation			View
ΔK	Stress intensity factor amplitude	Constant (Dimensions Req.)		M... root of ...	
ΔK_{thcf}	CFCP threshold	Constant (Material Prop.)		Megapascal sq... root of a meter	

Failure Mechanism

Name
Corrosion Fatigue

CFCP Hypothesis	fractured. Furthermore, this model is based on a static model (developed by Lal and Weiss) for crack propagation where the crack propagates when a tensile load exceeds the fatigue limit.

Limitations

Title	Description
Experimental Verification	This model has only been validated with experimental data from four specific aluminum alloys: LY12CZ, LC4CS, 7075-T7651, and 7049-T73. Furthermore, for the latter two, the model agreed with the data when the samples had a constant stress ratio (R).
Corrosive Environment	The model is said to accurately predict the CFCP rate for aluminum alloys in a 3.5% NaCl environment.

Constraints

Title	Description
Loading Frequency	For alloys 7075-T7651 and 7049-T73, the model showed agreement with experimental data when the loading frequencies were between 0.1 and 10 Hz.

Uncertainty Limits

Type	Uncertainty
N/A	N/A

Data or Information Needed from Outside Sources

Category	Source	Description
Physical Dimension(s)	User	Crack propagation length, from mechanical loading (x_f)
Physical Dimension(s)	User	Additional crack propagation length from corrosion (x_c)
Mechanical Properties	User	Stress intensity factor amplitude (ΔK)
Mechanical Properties	User	CFCP threshold (ΔK_{thcf})

Bibliographic Citation

Published Status	Source Type	Title	Authors

Current Status

- Over 5000 Technical Papers Evaluated
- Over 200 PoF Models Identified and Being Processed into the WARP Database:
  - Wear, creep, fatigue, time-dependent dielectric breakdown (TDDB), negative bias temperature instability (NDTI), hot carrier injection (HCI), electromigration
- RIAC WARP Website Went Public in August 2011
  - Over 275 Registered Members
  - Over 25 Registered Contributors

http://www.theriac.org/WARP/login/main_login.html

Future Work

- RIAC Core Operations and General Community Support Will Keep WARP Viable
- Original Intended Feature was On-Line Calculations and Output for Each PoF Model in WARP
  - Required software effort was cost-prohibitive
  - Negative impact on ability to populate WARP database
  - Emphasis placed on PoF model quantity and quality
- Adding This Capability Would Be a Valuable Asset for the PoF Community

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