Design and Development of Indian Materials Database

Speaker
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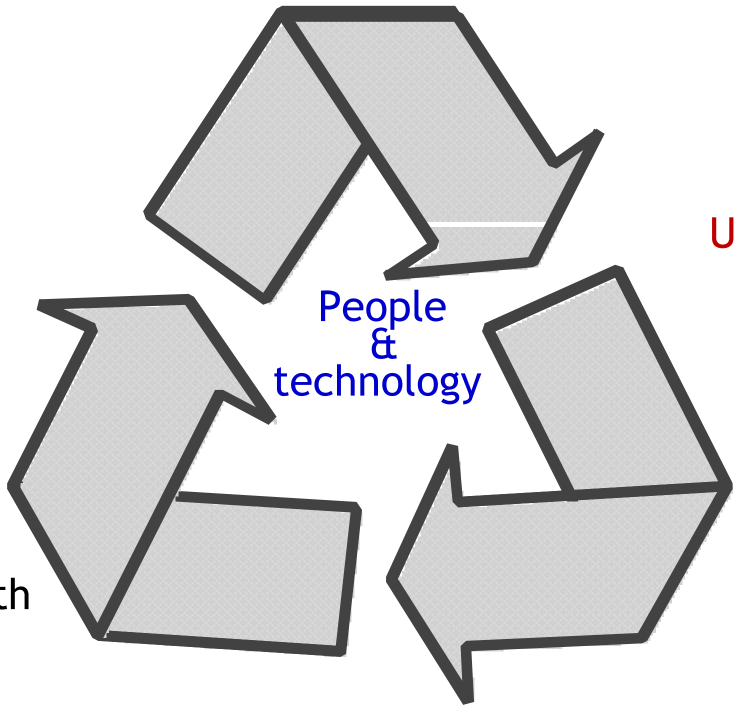
My talk is about

- Design, development and features of Indian Materials Database
- I will start with how growth in Information technology has made scientific databases useful to humanity
- Why we are the right people to do this activity and how we are going to sustain it

Growth in Information Technology

Has made Scientific Data reach Humanity

Also Scientific Data has propelled the growth of Science &Technology



Inspirations to Indian Material Database

- Large source of Data on Creep, Fatigue, Tensile, Fracture and corrosion properties on different structural materials have been generated in Indian Laboratories to provide vital data needed for power, space and chemical industries
- Scientist and engineers should know about latest updates of the data generated by National Laboratories
- A large scope for industries to use this data
- Building and verifying theoretical models and development of new materials
- Reducing energy demand through avoidance of sample materials, chemicals, experiments: Eventually help in reducing global warming

Indian Material Database

- World over , the websites for Material and Metallurgy are PDF, Excel or Word files. We felt if already published data from Indian laboratories can be given in database form ,it can be queried. Applications like data mining can be done on them .
- Indian Material Database should become a forum for fusion of data from industry, public, private sectors and research centres in India and then one day the world.
- The efforts on the formation of Indian database are to be in parallel and in synergy with rest of the world for our own industrial growth

Indian Materials Database - Features

- Development of a Database schema
  - Fast Access
  - Easy Transportation and further analysis
- Quality Data
  - Published experimental data
  - Development of Ontology Data
- Exchangeable Data
  - This was achieved by generating every displayed page as XML Page

Data Classification in the database

Material Class

- Material type
- Material condition
- Material Properties

Material Properties

- Material Class
- Detailed Properties

Source of data

- Organisation
- Journal / Conference
- Year of Publication
- Authors
- Title

Type of data

- Graphs
- Microstructure
- Tabular form

Indian Materials Database

- Materials in the database can be searched through Materials class, type, Properties, environmental conditions, source of data etc

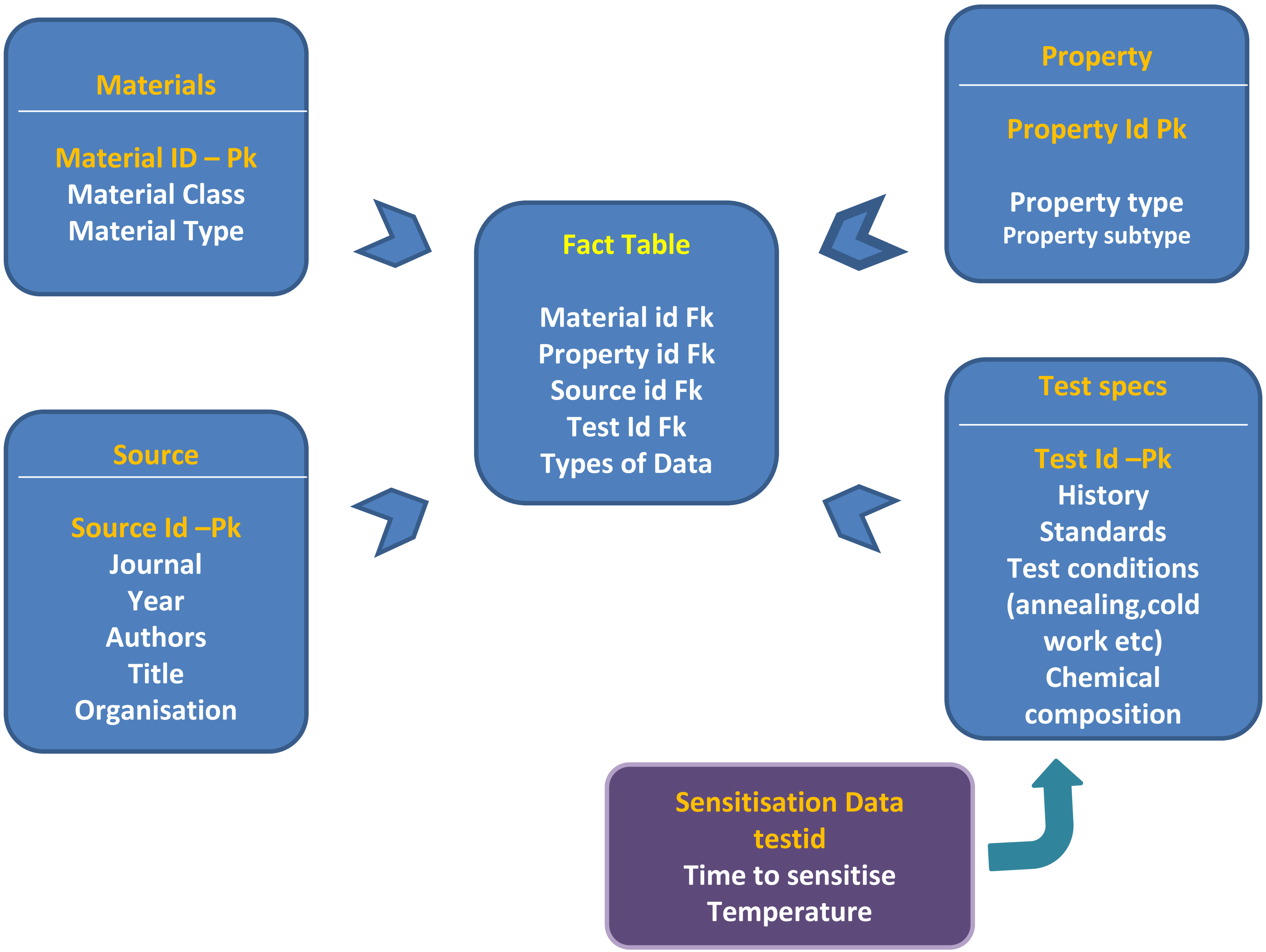
- Selecting an appropriate data modeling technique forms the foundation for the successful deployment of such a data, since it describes how data is to be represented and accessed.

- Dimensional database model of data ware housing is chosen

Dimensional Tables

- Dimensional modeling is the name of a logical design technique used for data warehouses. It presents the data in a standard, intuitive framework that allows for high-performance access.
- The dimensional modeling aims to implement a database that eases user navigation and enhances query performance.
- In this model, the "dimensions" of the data are the terms of reference, by which retrievals are done. In our case the dimensions are *Materials class, Property and Source*
- The data to be retrieved are collapsed into one or more "fact tables", related to each of the dimensions.

Dimensional Data Model of Indian Materials Database



Indian Materials Database-IMDB National Project

- Data collection, Database Design & Website development would be the responsibility of the Indira Gandhi Centre for Atomic Research, India
- Funded by Department of Science & Technology
- Website hosted by National information Centre
- Participated (Data given) by twenty premier institutes of India

Conclusion

- Database developed is sustainable as University Consortium and Leading Research Institute (Government organisation) will own the database and provide financial and manpower support for its maintenance
- Soon Industries will be invited for participation
- Website is waiting web application security certification for hosting on the web

Thank you

Contact

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Material Class

- Austenitic Stainless Steel
- Ferritic Steel
- Nickel
- Titanium Alloys
- Zirconium Alloys

Metallurgical Variables

Austenitic Stainless Steel

- Grain Size (316)
- Heat To Heat Variation (316)
- Thermal Ageing (Weld Joint(316 & 316LN)
- Weld Metal (316 & 316LN)
- Cold Wok (304, 316), Ti/C Ratio (D9)

Ferritic Steel

- Weld Joint
- Weld Metal (2.25Cr-1Mo)
- Austenitisation
- PWHT (2.25Cr-1Mo)

Material types

Ferritic Steel

- 2.25Cr-1Mo
- 2.25Cr-1Mo-9Cr-1Mo
- 9Cr-1Mo
- Modified 9Cr-1Mo
- Modified 9Cr-1Mo Steel Weld Joint

Nickel

- 1Fe-16%Al
- 1Fe-16%Al-1%C

Zirconium Alloys

- Zircalloy-2
- Zircalloy-4

Titanium Alloys

- 304L-SS+Ti Explosive Joint
- 304L-SS+Ti Friction Joint
- Commercial Purity Titanium
- Ti-5Ta
- Ti-5Ta-1.8Nb

Select a material

Austenitic Stainless Steel

Ferritic Steel

Nickel

Titanium Alloys

Zirconium based alloy

Search

Search for Materials

Search for Properties

Search for Graphs

Search for MicroStructures

Search for Source

Indian Materials Database

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Select material conditions

Austenitic Stainless Steel

Material Type

- 304 SS
- 316 SS
- 316 SS Weld Metal
- 316(L) Weld Metal
- 316(N) Weld Metal
- 316L BaseMetal
- 316L(N)
- 316L(N) / 316 Weld Joint
- 316L(N) Base Metal
- 316L(N)2
- 316LN BaseMetal
- 316LN Weld Joint
- 316LN Weld Metal
- 316LN(3)
- 316LN(3) Weld Metal
- 316LNH

Condition1

mill annealed

Condition2

0% cold worked

Condition3

200 K/h (CCR)

Properties

- *SENSITIZATION*

Search

- Search for Materials
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Material Properties

- Mechanical Property
  - Tensile
  - Creep
  - Fatigue
    - Low Cycle Fatigue
    - Creep Fatigue Interaction
    - Thermo Mechanical Fatigue
  - Hardness
    - Fracture Toughness
    - Creep Crack growth
    - Fatigue Crack growth
- Corrosion Properties
  - ⋮
- Characterisation of Material
  - ⋮

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INDIAN MATERIALS DATABASE

Search for : Materials Properties Graphs Microstructures

Search by Properties

- PROPERTIES
  - MECHANICAL
    - TENSILE
    - CREEP
    - FATIGUE
      - LOW CYCLE FATIGUE
      - CREEP FATIGUE
      - THERMO MECHANICAL FATIGUE
    - HARDNESS
  - CORROSION
    - UNIFORM
    - SENSITIZATION
    - PITTING
    - HYDROGEN TRANSPORT
    - HIGH TEMPERATURE
    - SODIUM CORROSION
    - BIOFOULING
  - CHARACTRIZATION
    - NON DESTRUCTIVE TESTING TECHNIQUE
      - EDDY CURRENT TESTING
      - ULTRASONIC SPECTROSCOPY

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Select a Property

- PROPERTIES
  - CORROSION
    - BIOFOULING
    - HIGH TEMPERATURE
    - HYDROGEN TRANSPORT
    - PITTING
    - SENSITIZATION
    - SODIUM CORROSION
  - MECHANICAL
    - CREEP FATIGUE
    - HARDNESS
    - LOW CYCLE FATIGUE
    - THERMO MECHANICAL FATIGUE

Search

Search for Materials
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Search for Graphs
Search for MicroStructures
Search for Source

Select source of data

Organization

IGCAR

Year

Select

Publication

Select

Titles

High Temperature low cycle fatigue and creep-fatigue interaction behaviour of 316 and 316L(N) weld metals and their weld joints

A comparative evaluation of low cycle fatigue and creep fatigue interaction behaviour of 316, 316(N) and 316L(N) welds and weld joints

A comparative evaluation of low cycle fatigue behaviour of Type 316L(N) base metal, 316 weld metal and 316L(N)/316 weld joint.

Artificial neural network approach to low cycle fatigue and creep-fatigue life prediction of modified 9Cr-1Mo ferritic steel

Biomineralisation of manganese on titanium surfaces exposed to sea water

Characterization of Dynamic Strain Ageing Effects During Low Cycle Fatigue of Type 316L(N) Stainless Steel

Comparative evaluation of strain controlled low cycle fatigue behaviour of solutionised and prior cold worked 316L(N) stainless steel.

Cyclic oxidation of P91 by thermogravimetry and the investigation of integrity of the scale by transient mass gain method

Effect of hold-time on low cycle fatigue behaviour of nitrogen bearing 316L stainless steel

Effect of temperature on the low cycle fatigue behaviour of nitrogen

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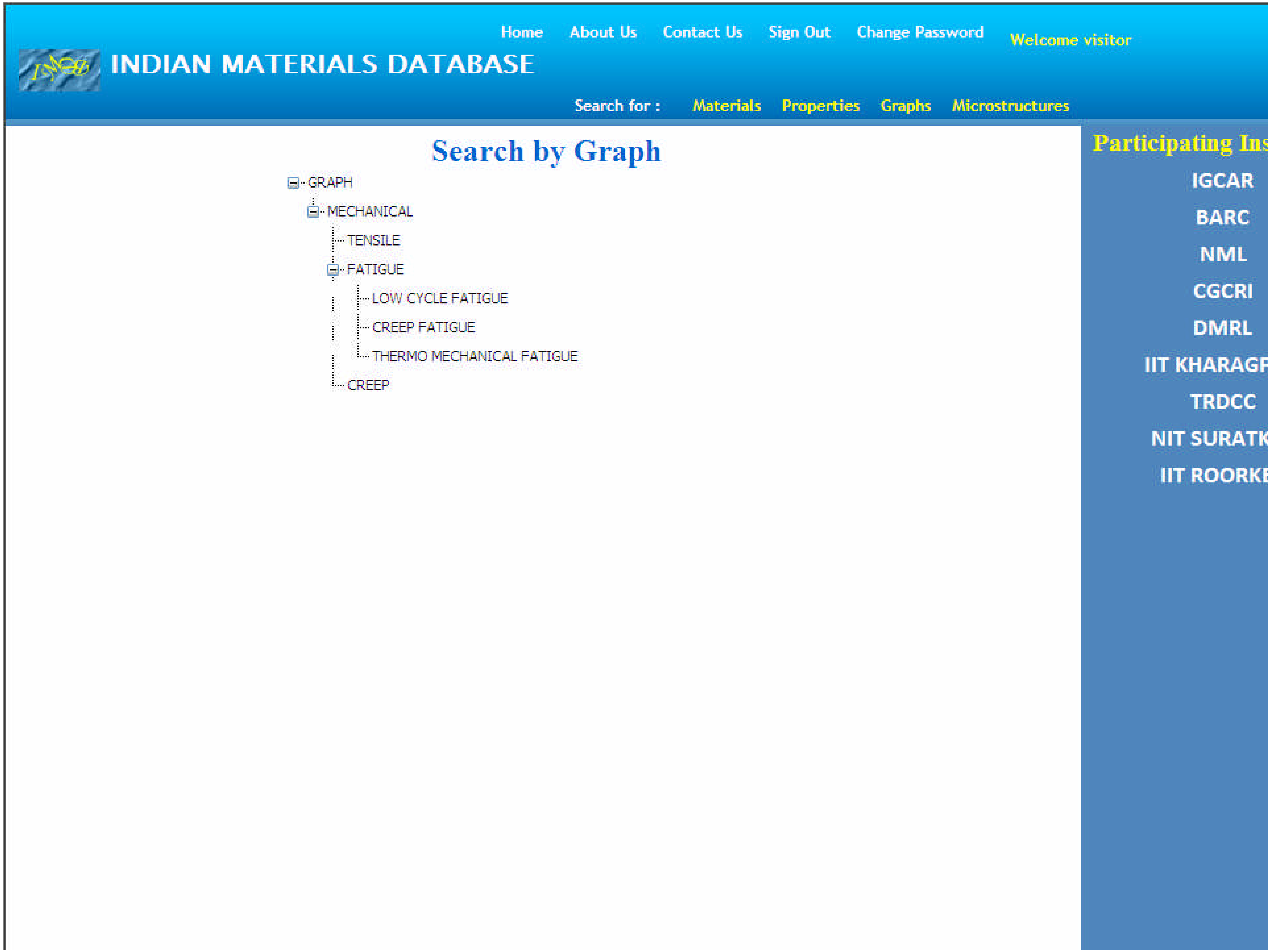
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Thermo Mechanical Fatigue Data

Austenitic Stainless Steel -->316L BaseMetal

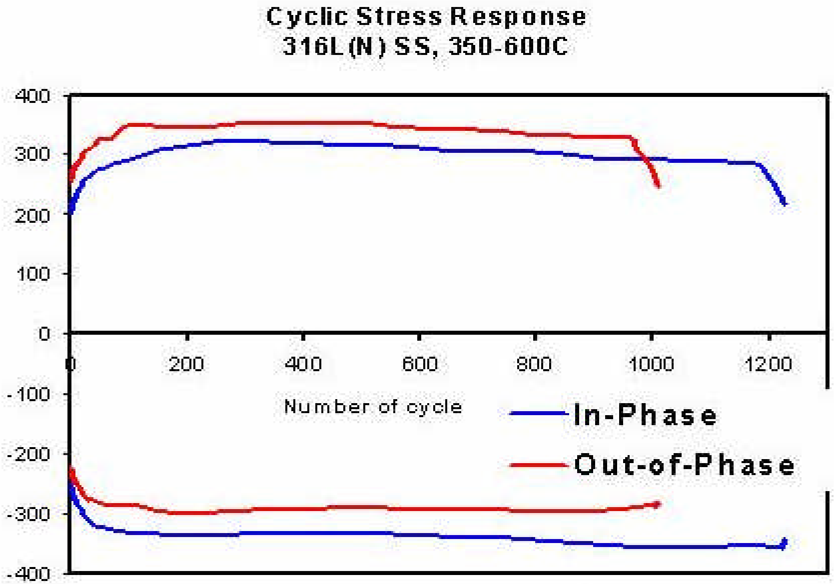
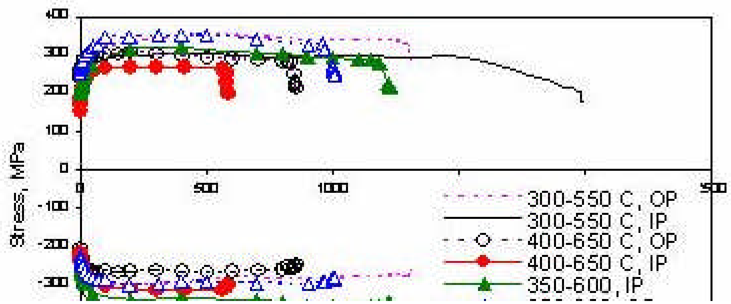


Fig.1.Mean stresses: IP cycling - COMPRESSIVE, OP cycling – TENSILE Plastic strains: Comparable in IP and OP cycling



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INDIAN MATERIALS DATABASE

Search for : Materials Properties Graphs Microstructures

Search by MicroStructure

- MICROSTRUCTURE
  - MECHANICAL
    - TENSILE
    - FATIGUE
      - LOW CYCLE FATIGUE
      - CREEP FATIGUE
      - THERMOMECHANICAL

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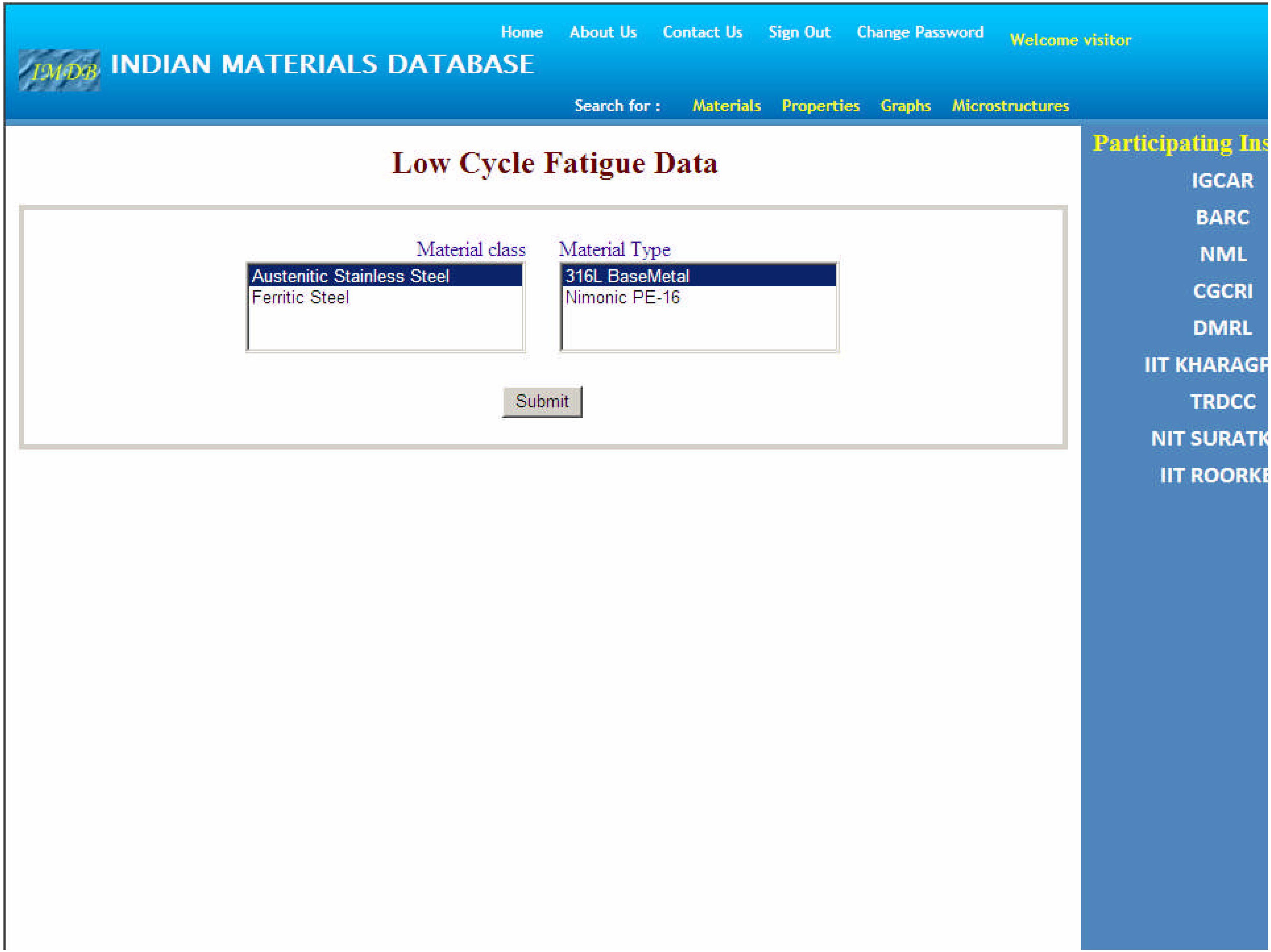
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Ferritic Steel
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316L BaseMetal
Nimonic PE-16
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Low Cycle Fatigue Data

Austenitic Stainless Steel -->Nimonic PE-16

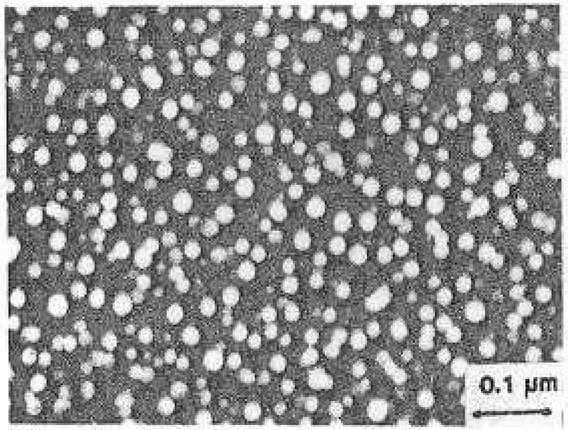

Fig. 1. Dark field micrograph showing gє precipitate morphology, Nimonic PE-16 before testing

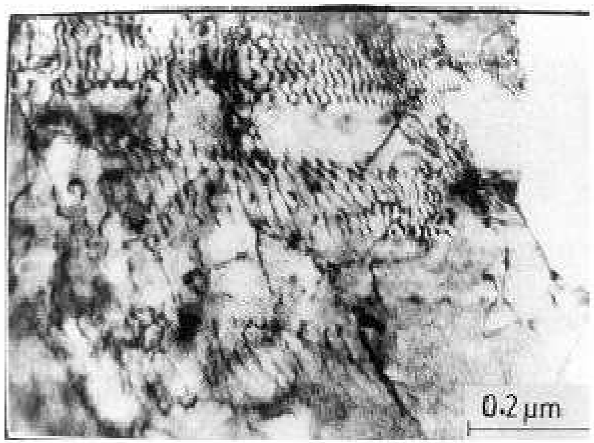

Fig. 2(a). Planar Dislocation arrangement, Microstructure A, Strain amplitude +0.4%

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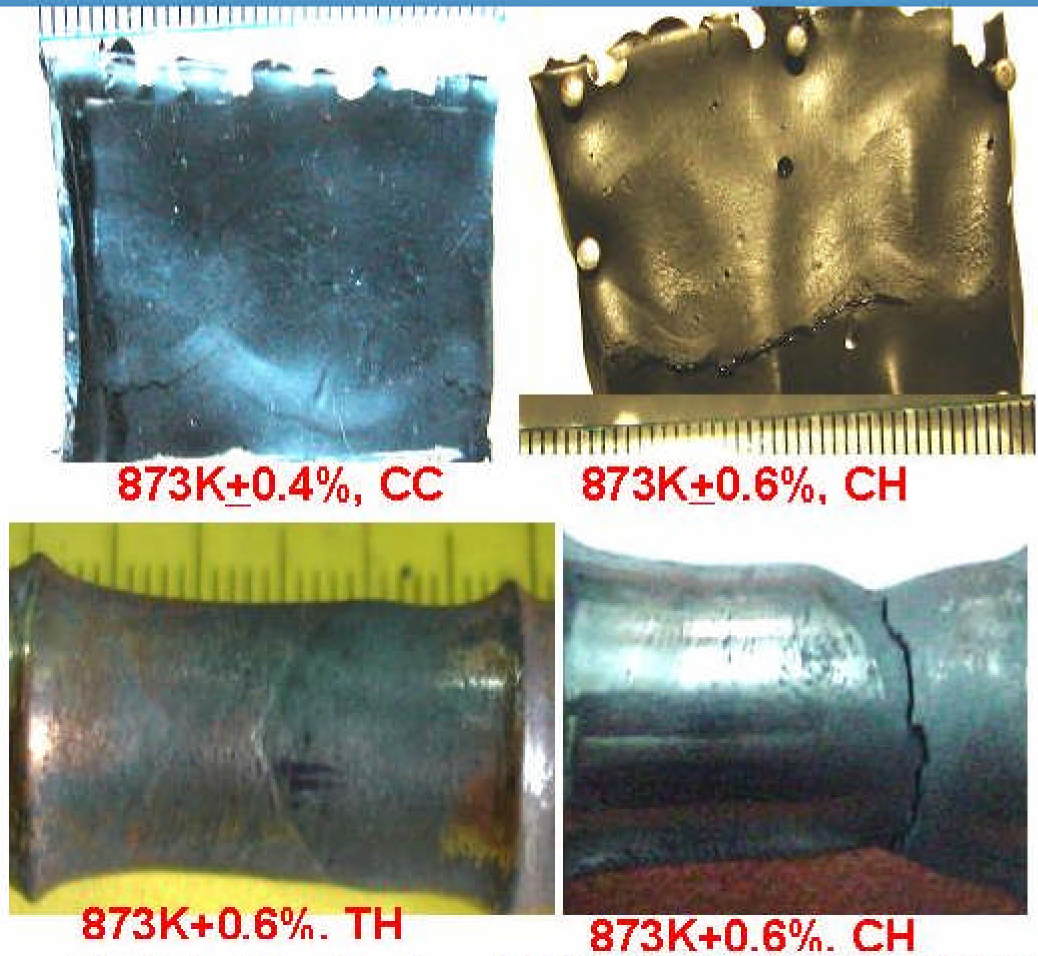
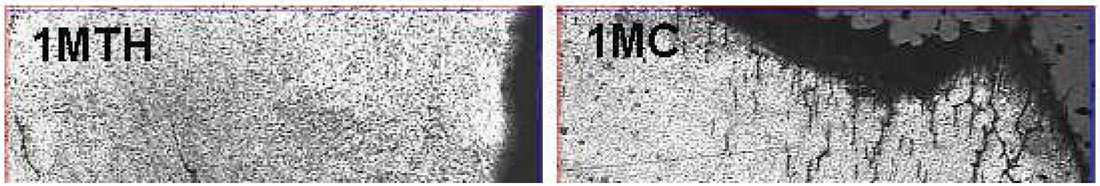


Fig. 4. Evidence for strain localization in heat affected zone, Mod.9Cr-1Mo Steel (Plate Material), Weld Joint, 873 K during Hold Time.



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Uniform

Selected Material Detail	
Code	Zirconium based alloy
Type	Zircaloy-2
Chemical Composition	0.230Fe-0.114Cr-0.005Ni-0.113O-0.003N-0.001H-1.490Sn-0.014C-0.008Si-0.003Hf-balance Zr
History	Nil
Test Standard	Nil
Source	JOURNAL NAME: Progress in Nuclear Energy, Vol 48, Issue 4, May 2006, pp. 283-313, " Materials development and corrosion problems in nuclear fuel reprocessing plants" , Baldev Raj and U.Kamachi Mudali.

Experiment Results

Corrosion Rate (mpy) of Materials in Simulated Radioactive Solution.

Materials	Temperature (K)	Electrolytic Dissolution(UC in 6M HNO3)	Refluxing Condition(UC in 12M HNO3)
Zircaloy-2	338	3	5,2
Zircaloy-2	358	6,1	4
Zircaloy-2	363	0	16,18

Corrosion rate of materials after 3-Phase corrosion test in boiling nitric acid solution containing Silver and Chromium ions.(Corrosion Rate in mpy).

Materials	100h	200h	300h	400h	500h	100h	200h	1300h	1400h	1500h	1100h	1200h	2300h	400h	500h
Zircaloy-2	0.2	0.2	0.4	0.2	0.2	1.1	0.6	0.0	0.4	1.5	0.2	0.0	0.4	0.6	0.6

Generate XML

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Hydrogen Transport

Selected Material Detail	
mcode	Ferritic Steel
mtype	2.25Cr-1Mo
subtype	
history	
chemcom	0.11C-0.31Si-0.50Mn-0.025P-2.25Cr-0.90Mo-balanceFe
teststd	ASTM pratice G148-97(reapproved 2003)
condition1	
condition2	
condition3	
condition4	

title	publication	citation	organization	year
	Journal of Nuclear Materials	N.Parvathavarthini,S.Saroja, R.K.Dayal,H.S.Khatak ,J.Nucl.Materials, 288 (2001)187-196	IGCAR	2001

Hydrogen Permeability (P), Diffusivity (D), Solubitllity(S) Properties

Heat Treatment	Px10^12 (mol/cm s)	Dx10^8 (cm2/s)	Sx10^4 (mol/cm3)
1193K-60minutes-air cooled	7.75 (+/-) 0.12	51.9 (+/-) 3.9	0.149 (+/-) 0.009
1193K-60minutes-air cooled+1023K-480minutes-air cooled	6.83 (+/-) 0.06	327 (+/-) 18.7	0.021 (+/-) 0.001
1193K-60minutes-air cooled+1023K-60minutes-air cooled	6.86 (+/-) 0.15	160 (+/-) 1.8	0.043 (+/-) 0.001
1193K-60minutes-air cooled+973K-480minutes-air cooled	8.31 (+/-) 0.08	120 (+/-) 1.8	0.069 (+/-) 0.001
1193K-60minutes-air cooled+973K-60minutes-air cooled	8.04 (+/-) 0.18	98.2 (+/-) 6.7	0.083 (+/-) 0.007
1193K-60minutes-furnace cooled	9.44 (+/-) 0.38	400.00 (+/-) 29.8	0.024 (+/-) 0.001
1193K-60minutes-water quenched	6.80 (+/-) 0.35	44.7 (+/-) 2.4	0.152 (+/-) 0.006

Generate XML

Search

Quality

- Generation of data based on recognised standard test methods

- Tests repeated for reliability

- Published experimental data (already peer reviewed)

Ontology

- Materials Property and its data environment (is an essential information for the material and its product)

- It is necessary to communicate the information about the meaning of these properties and their values efficiently and without ambiguity

Ontology Data
Material Class
Material Type
Material Property
Chemical Composition
Material History
Material Standard
Material Source Journal name, Year of Publication, Authors, Title

Indira Gandhi Centre for Atomic Research -IGCAR

- Indira Gandhi Centre for Atomic Research (IGCAR) is a part of Department of Atomic Energy
- We have a very strong Materials wing
- Already we have VAMAS database, Thermo calc materials database for dynamic phase diagrams at any point in time etc
- We felt the materials developed, experiments conducted in IGCAR and other premier institutes of India should be made into a database

National Informatics Centre

- National Informatics Centre (NIC) is a premiere S & T institution of the Government of India, established for providing

  e-Government / e- Governance Solutions adopting best practices, integrated services and global solutions in Government Sector.

Department Of Science & Technology

(An autonomous body)

– Objective is to promote new areas of Science & Technology and to play the role of a nodal department for organising, coordinating and promoting S&T activities in the country.

Indian Materials Database

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Welcome to Indian Materials Database

Valuable and extensive data using standard techniques have been generated in India in the past three decades on mechanical and corrosion properties of various materials which are utilized in different power plants and chemical industries. These data are accessible from individual laboratories either in the form of journal articles or departmental reports. A need has been felt by the scientific communities that these data generated should be freely available and accessible for scientific analysis and engineering. In order to carry out this task, a working group under national committee of the Indian National Scientific Academy (INSA) for CODATA was formed during 2005. The work is being carried out by this group to collect the data from various important laboratories in India, particularly on mechanical and corrosion metallurgy for its free access to the scientific communities. The task of this database is accomplished with the support from Department Of Science and Technology (DST) , Indian National Science Academy (INSA) and Indian Institute of Metals (IIM).

Search

Search for Materials
Search for Properties
Search for Graphs
Search for MicroStructures
Search for Source

Navigation Menu of Material Database

- Data on a Material
  - Material types
  - Material conditions while testing
  - Material Properties
- Data on a Property
  - Property of different Materials
- Source of Data
  - Data from an Organisation
  - Published in Journal/Conference
  - Author
  - Year of Publication
- Type of Data
  - Tabular Data
  - Graphical Data
  - Microstructure Images

Data Ware House

- Data warehouse is the term used for a computer database which is the collection and storage of data from multiple and usually varied sources into one comprehensive and easily manipulated database.
- This collection is then used to manage information efficiently, analyze the collected data and perform data mining for deducing new information.

Scientific Research

- Recent achievements in information technology have changed the way scientific research is being carried out.
- Scientific data has been one of the key components that have propelled the growth of science and technology.
- Scientific databases are the liaison between Science & Humanity
  - Weather predictions ,Health care, Agricultural databases
  - Databases on Biodiversity in an area etc