DIGIMAT USERS' MEETING 2011

The Material Modeling Conference

A Standardized Methodology for the Digimat MX Reverse Engineering Process

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DatapointLabs, USA

Stream ENGINEERING

DatapointLabs

expert material testing

EST 1995

ISO 17025 Quality

Material Model Calibration Services

- Since 1995 -

DatapointLabs

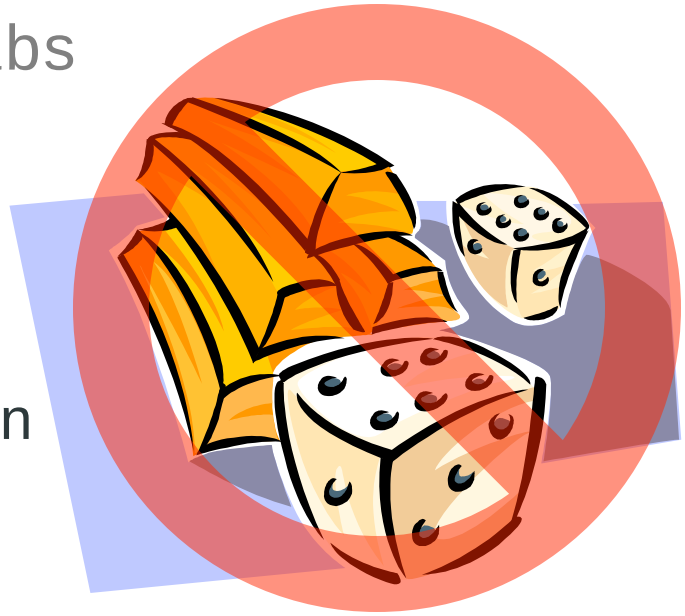
expert material testing

- Scope
  - ✓ Over 200 physical properties
    - Mechanical properties
    - Thermal properties
    - Flow properties
- Technical Heritage
  - ✓ Cornell University & C-Mold
    - Cornell Injection Molding Program
- Expertise
  - ✓ *TestPaks* for CAE/ product development
    - 25 CAE codes supported
  - ✓ >1,000 materials tested per year
    - Wide variety of materials

tensile
compressive
flexural
stress-strain
Poisson's ratio
high strain rate
bulk modulus
fatigue
visco-elasticity
stress relaxation
creep
friction
hyperelasticity
thermal expansion
thermal conductivity
specific heat
PVT
rheology

TestPaks® from DatapointLabs

- Material Testing
  +
  Material Parameter Conversion



no gamble

- ✓ precise
- ✓ confidential
- ✓ fast & economic
- ✓ expert technical support

available worldwide

Outline

- 1. Standardized test methodology for DIGIMAT MX
  - ✓ Test plaque
  - ✓ Molding
  - ✓ Specimen profile
  - ✓ Machining procedure
  - ✓ Testing procedures
    - Quasi-static
    - Crash
    - Creep
    - Fatigue (under development)
- 2. Obtaining DIGIMAT data from Matereality databases
- 3. NEW- DIGIMAT MX reverse engineering service
    - e-Xstream + DatapointLabs joint cooperation

The DIGIMAT MX *TestPak* …how it works

- Order your Digimat MX *TestPak* at datapointlabs.com
- Ship one 25kg bag of material
  - ✓ DHL pick-up service available
- One week for molding
- One week for testing
- DIGIMAT MX-ready data delivered via Internet
  - ✓ Pdf test report
  - ✓ Digital data to client material database at www.matereality.com

Basic DIGIMAT MX *TestPak* Protocol

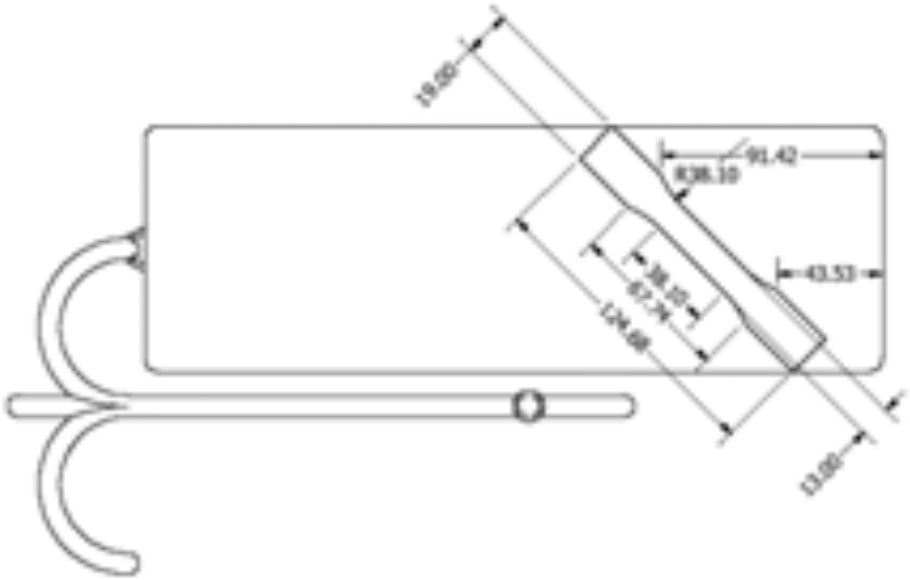
- Critical points to obey for experimental measurements (e-Xstream engineering)

  ✓ Experimental measurements

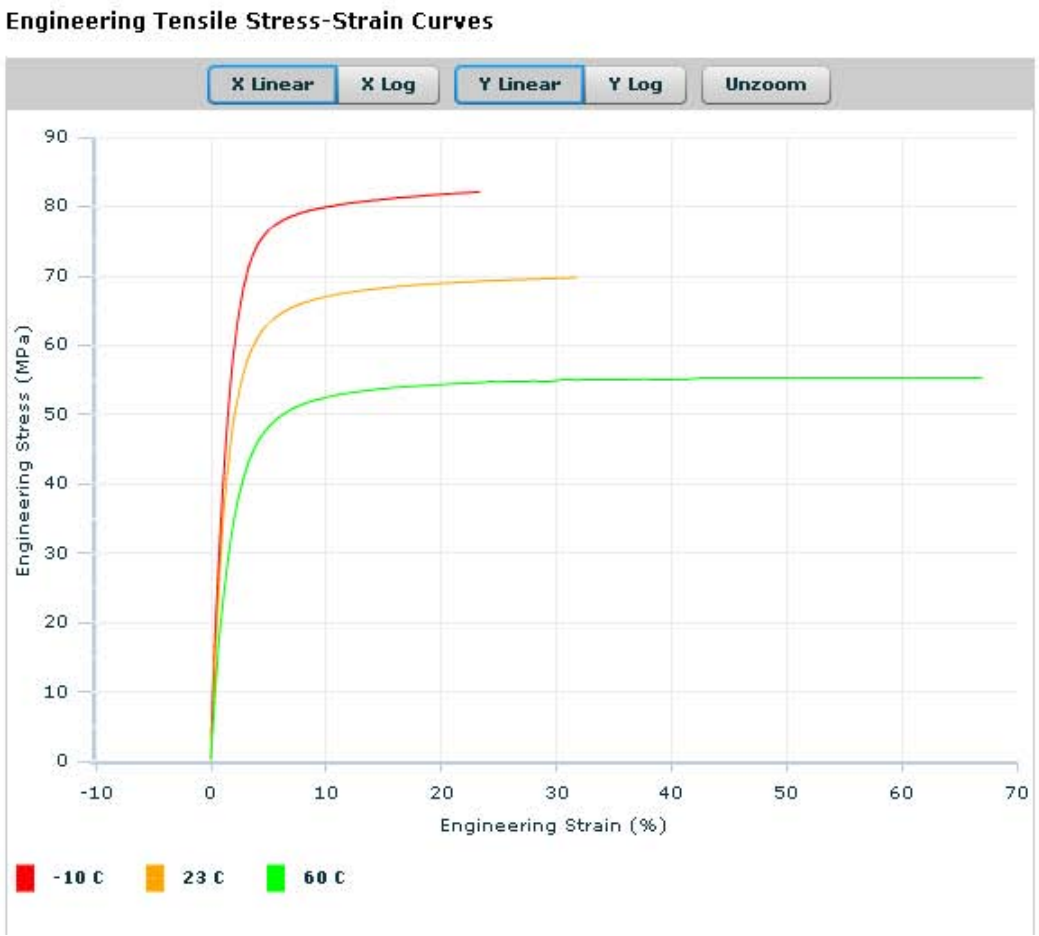
  - Obey the correct relative humidity!!!
    - One of the classical issues
  - Choose a good plate geometry
    - Datapoint Labs
  - Clean up experimental curve
    - 0 MPa stress at 0% strain
      - » Initial step of RE evaluation of the Young's modulus

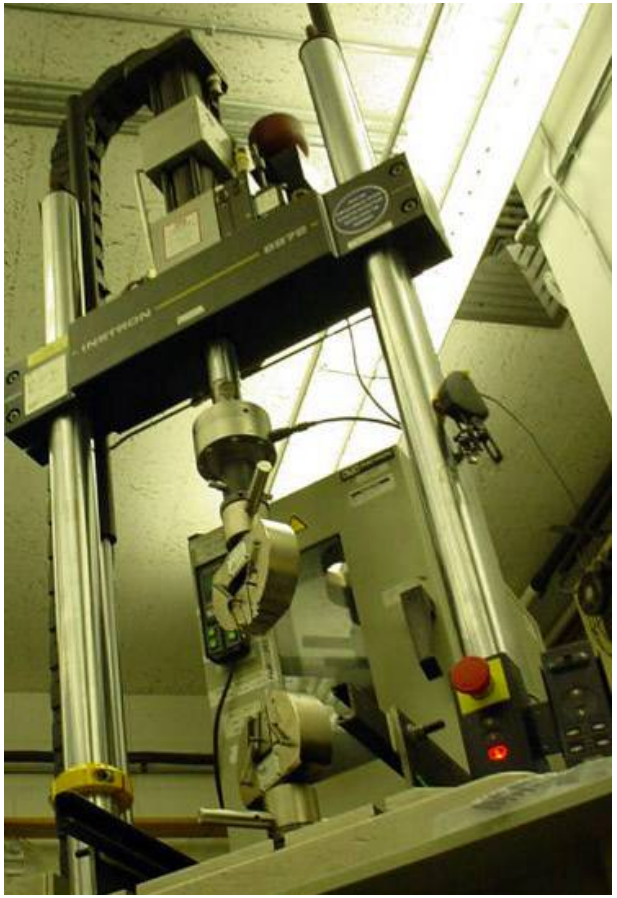
Basic DIGIMAT MX *TestPak* Protocol

- Mold 100X200X3.16mm plaques
  - ✓ Edge gated on 100 mm end
  - ✓ Long flow length
  - ✓ Fully developed flow
  - ✓ Highly fiber orientation
- Cut test specimens by CNC
- 5 specimens each (0°, 90° ,other orientations…)
- Obtain true stress-strain data

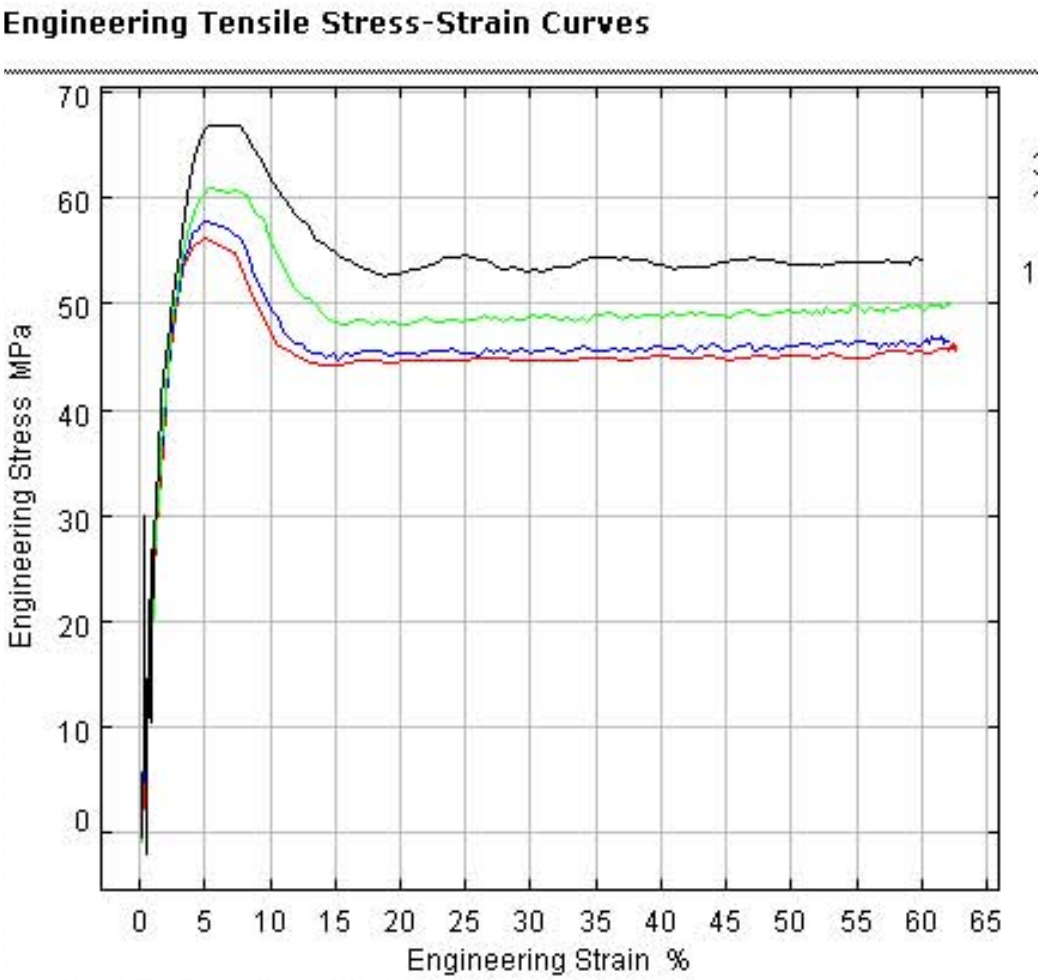


Stress-strain data





Example: Crash properties for DIGIMAT



DIGIMAT *TestPak* options

- Additional directions (10°, 20°, 45°)
- Thermomechanical (from –40° to 150°C)
- Strain-rate dependent (0.01 to 100/s)
- 3 point bend data (quasi isotropy)
- Tensile bar data (coarse fit)
- Visco-elasticity
- Low cycle fatigue (Lemaitre-Chaboche)
- High cycle fatigue (under development)

DIGIMAT MX *TestPak* outputs

- Reverse Engineering of DIGIMAT material model

  - ✓ Injection molding simulation of the dumbbells

    - Obey the experimental injection conditions!
    - Extract layered microstructure

      – O.k.:

        » Extract OT of representative element per layer

      – Best:

        » Compute average OT per layer by extracting the dumbbell

DIGIMAT MX *TestPak* outputs

- Datapoint Labs:
  - ✓ CAD drawings of plaque and specimens
  - ✓ Plaque molding conditions

DIGIMAT MX *TestPak* outputs

- Reverse Engineering of DIGIMAT material model

  - ✓ Digimat-MF
    - Build first a high quality material model
    - Material model should contain

      – Microstructure
        - » Volume fraction (final quality)
        - » Orientation (layered!) (final quality)
        - » Aspect ratio (rough assumption)

      – Failure indicator if needed
        (see later)

DIGIMAT MX *TestPak* outputs

- Reverse Engineering of DIGIMAT material model

✓ Digimat-MX
- Import experimental curves
- Reverse engineer step-by-step
  1. Elastic part + aspect ratio
  2. Plastic part
  3. Failure
     - » If non-FPGF

✓ Digimat-MF
- Reverse engineer
  - – Failure
    - » If complex & FPGF

DIGIMAT MX *TestPak* outputs

- Datapoint Labs:
  - ✓ True stress strain data (M-204) at 23°C
    - ✓ 0°, 90° orientation from plaque
- Customer
  - ✓ Performs DIGIMAT MX Reverse Engineering
  - ✓ Data is ready for FEA

matereality

Part 2: DIGIMAT CAE Modeler

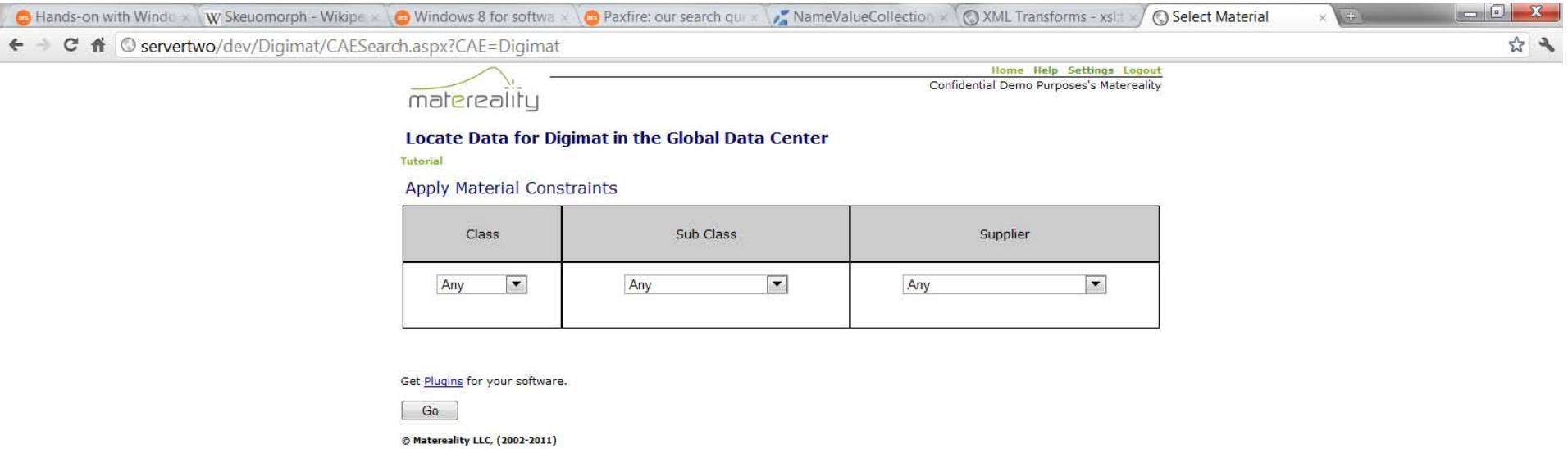
Workflow to locate and extract material data from your Matereality database to DIGIMAT and to import data into Digimat-MX materials exchange platform

DIGIMAT CAEmodeler

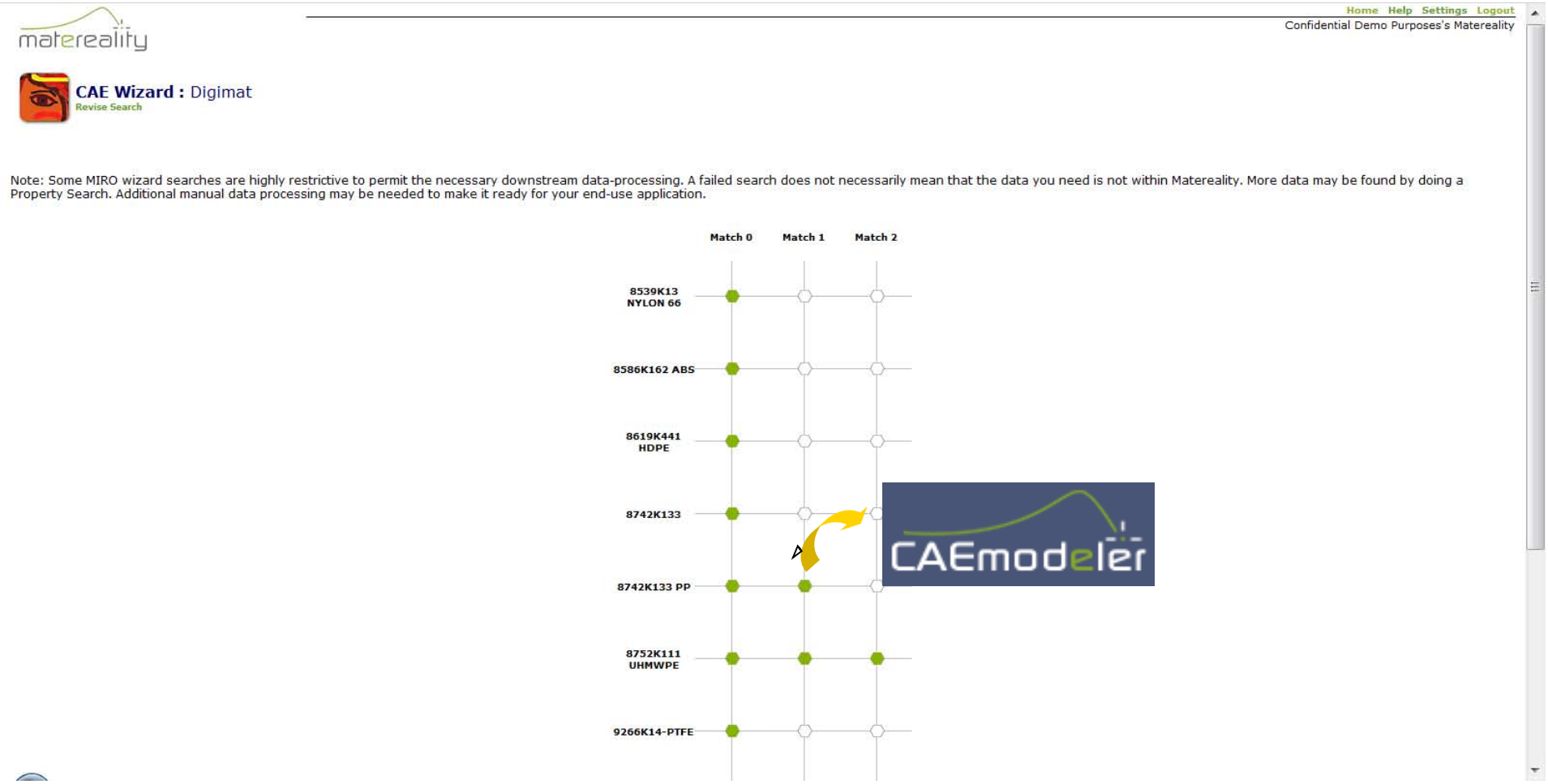
You can extract data from the Global Data Center, company workgroup or your own material database

Next, Select the CAE software of interest: DIGIMAT

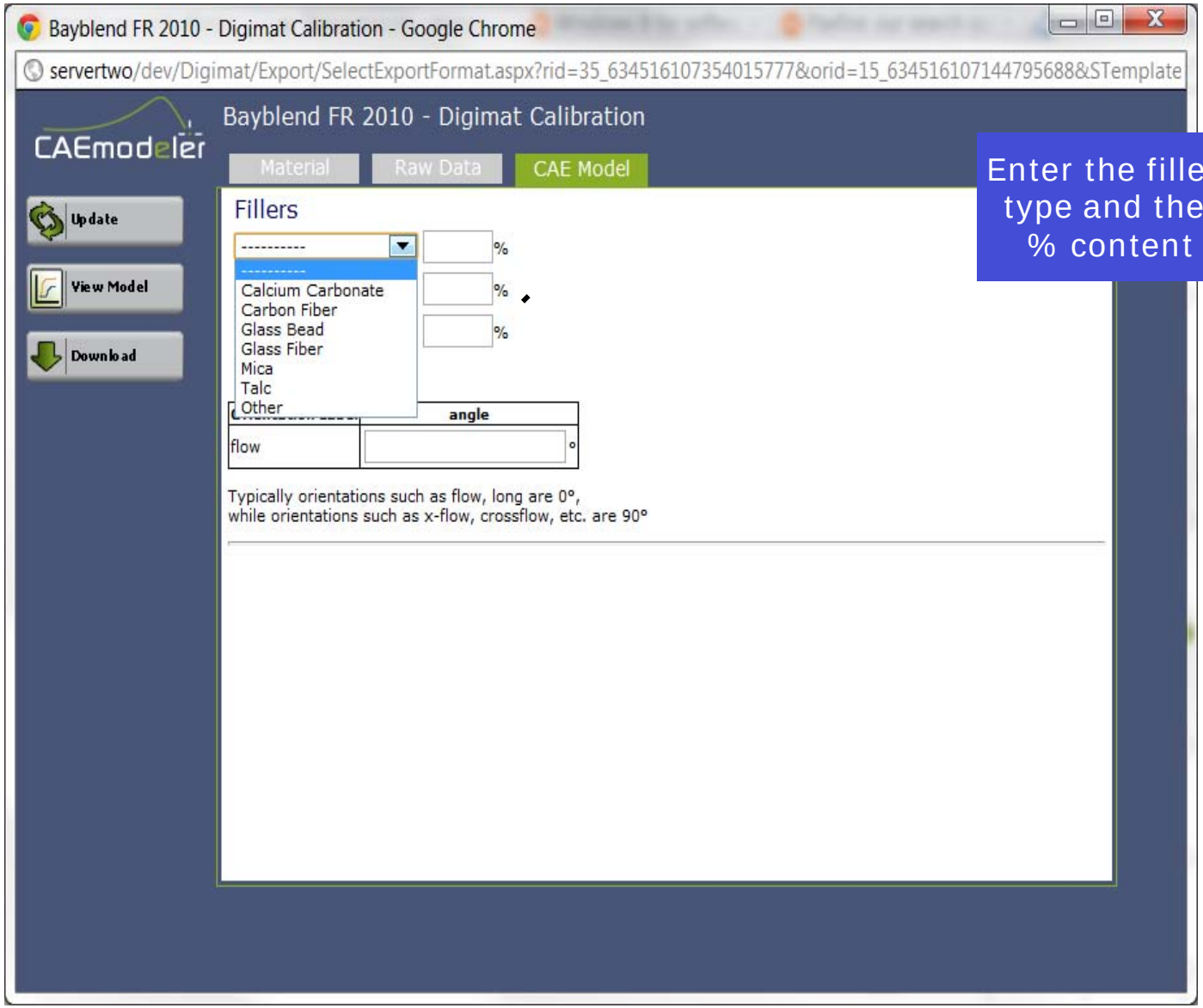
Start DIGIMAT CAE Modeler



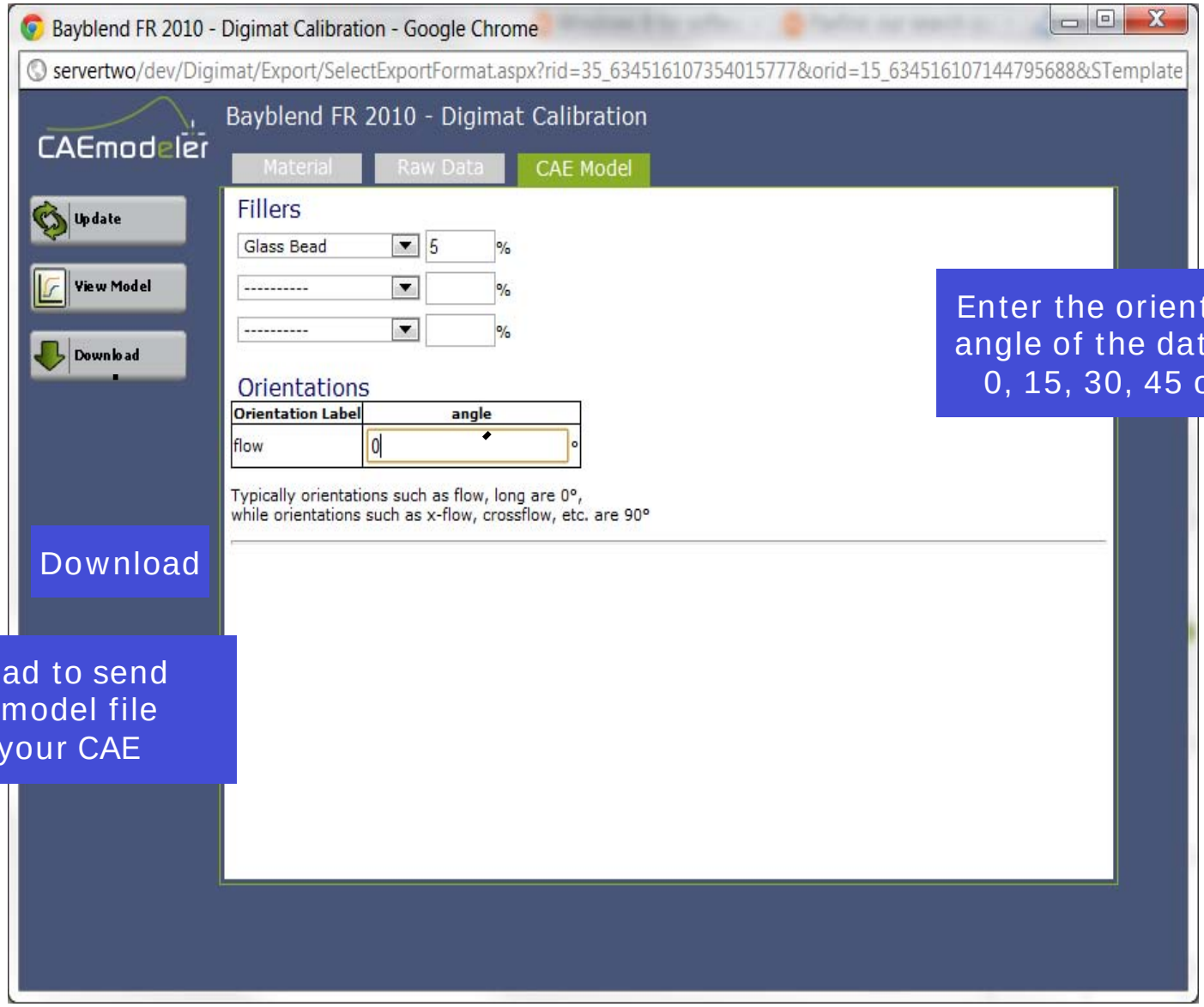
View available DIGIMAT data



Add additional required information



Add orientation information

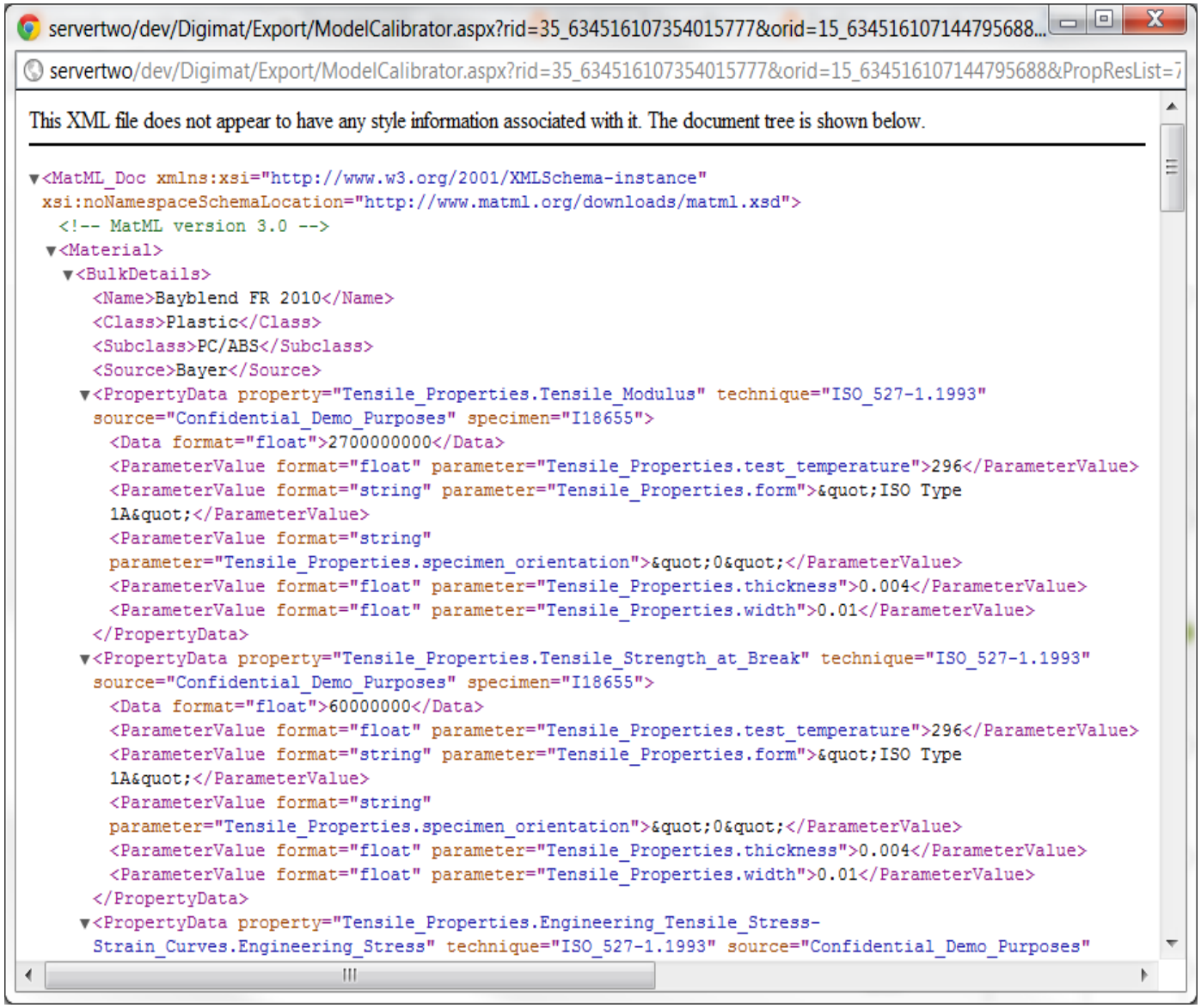


Enter the orientation angle of the data. eg. 0, 15, 30, 45 or 90

Download

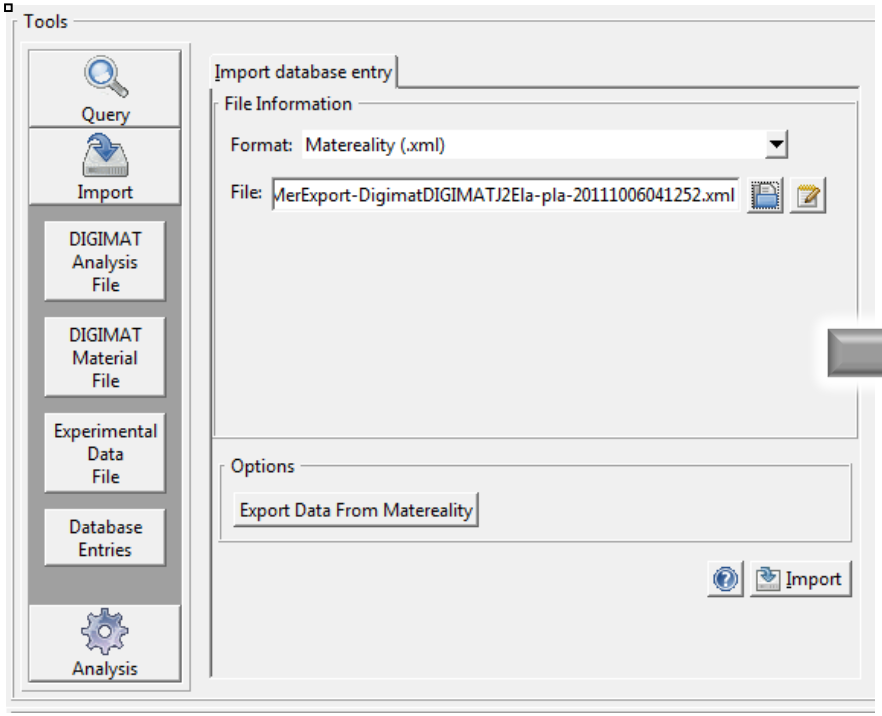
Click Download to send the material model file directly into your CAE

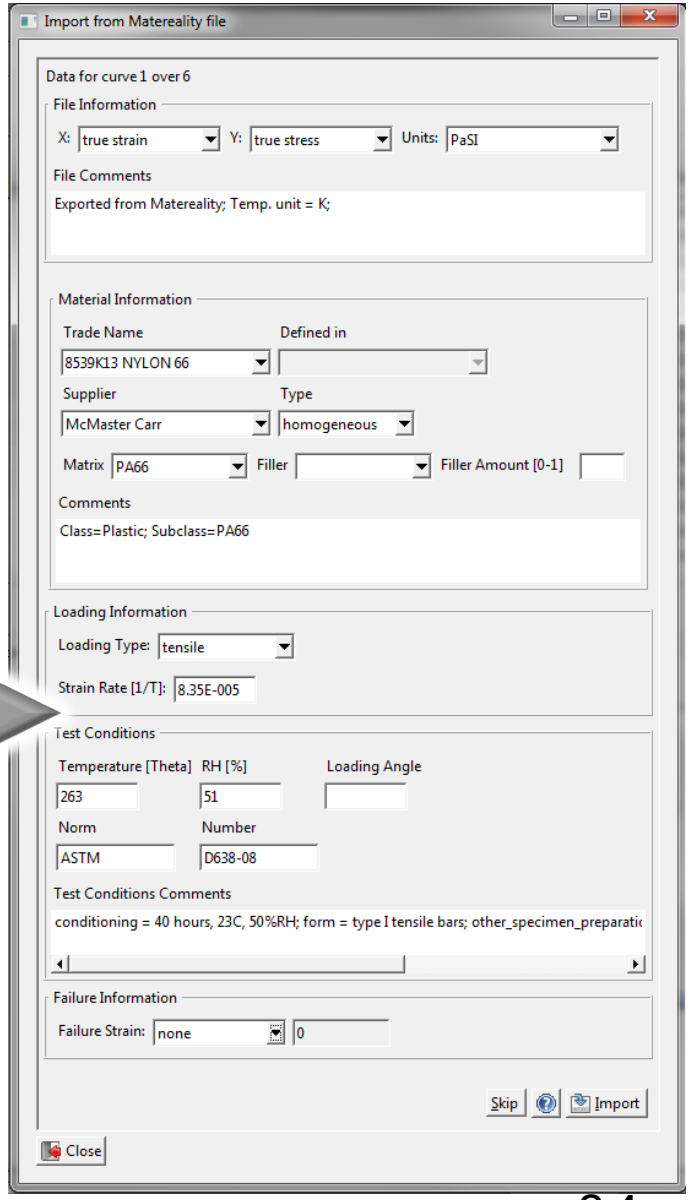
DIGIMAT-ready XML output



Digimat-MX Interface

- Import of data
  - ✓ Selection of curve to import
  - ✓ Data check
  - ✓ Experimental curves ready to use





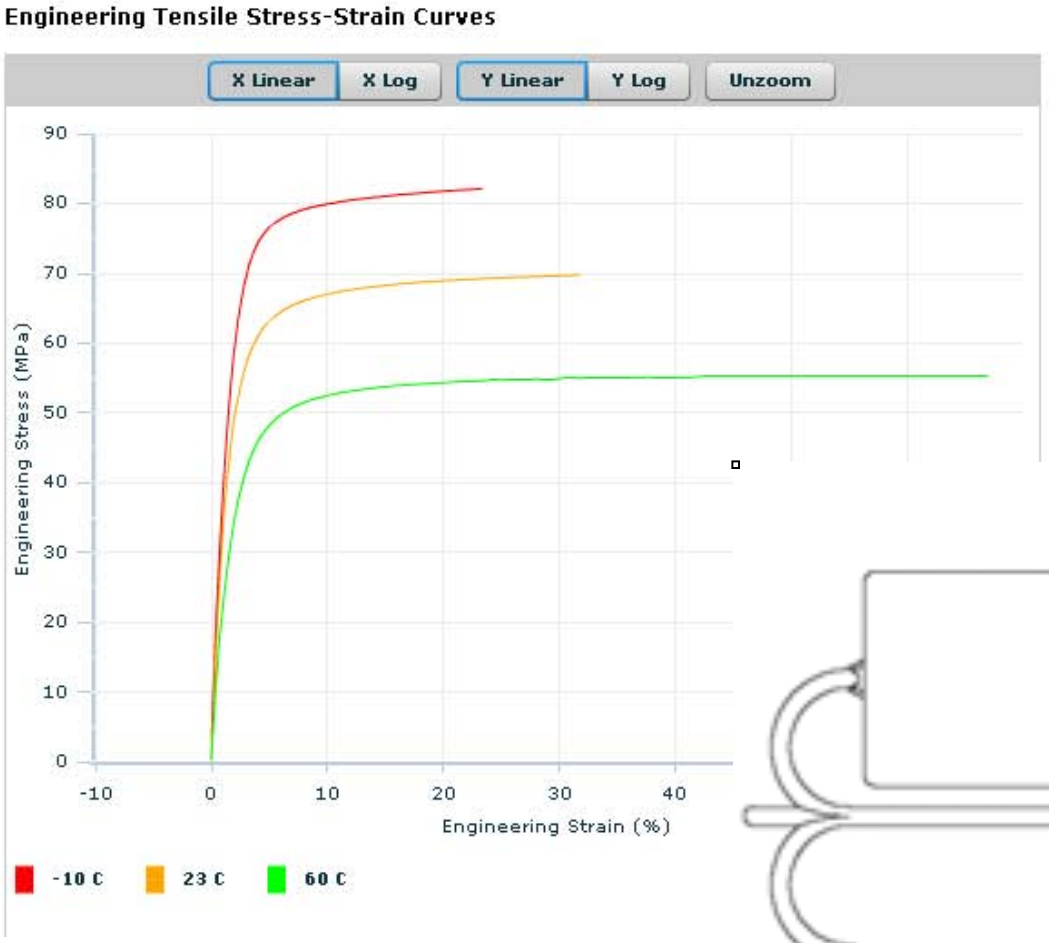
Part 3

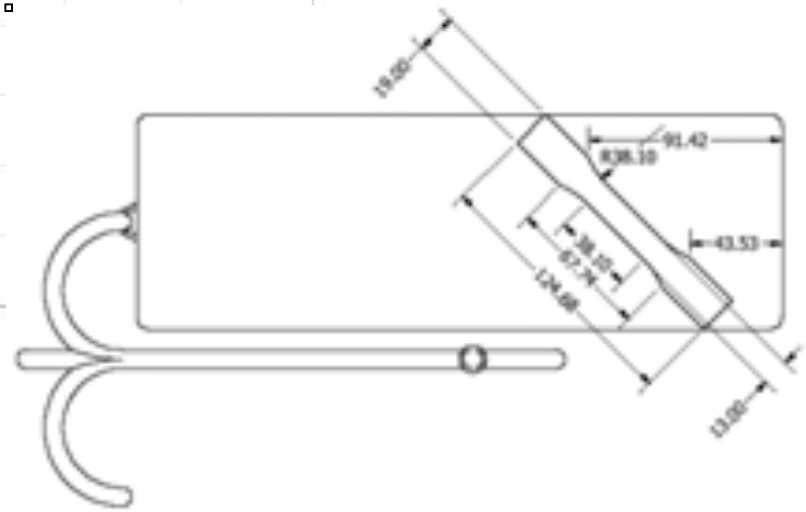
NEW DIGIMAT MX Reverse Engineering Service

→ e-Xstream + DatapointLabs joint cooperation

NEW DIGIMAT MX Reverse Engineering Service

- Testing performed at DatapointLabs





NEW DIGIMAT MX Reverse Engineering Service

- DIGIMAT MX-ready data sent to e-Xstream for reverse engineering
  - ✓ Using full expertise / experience

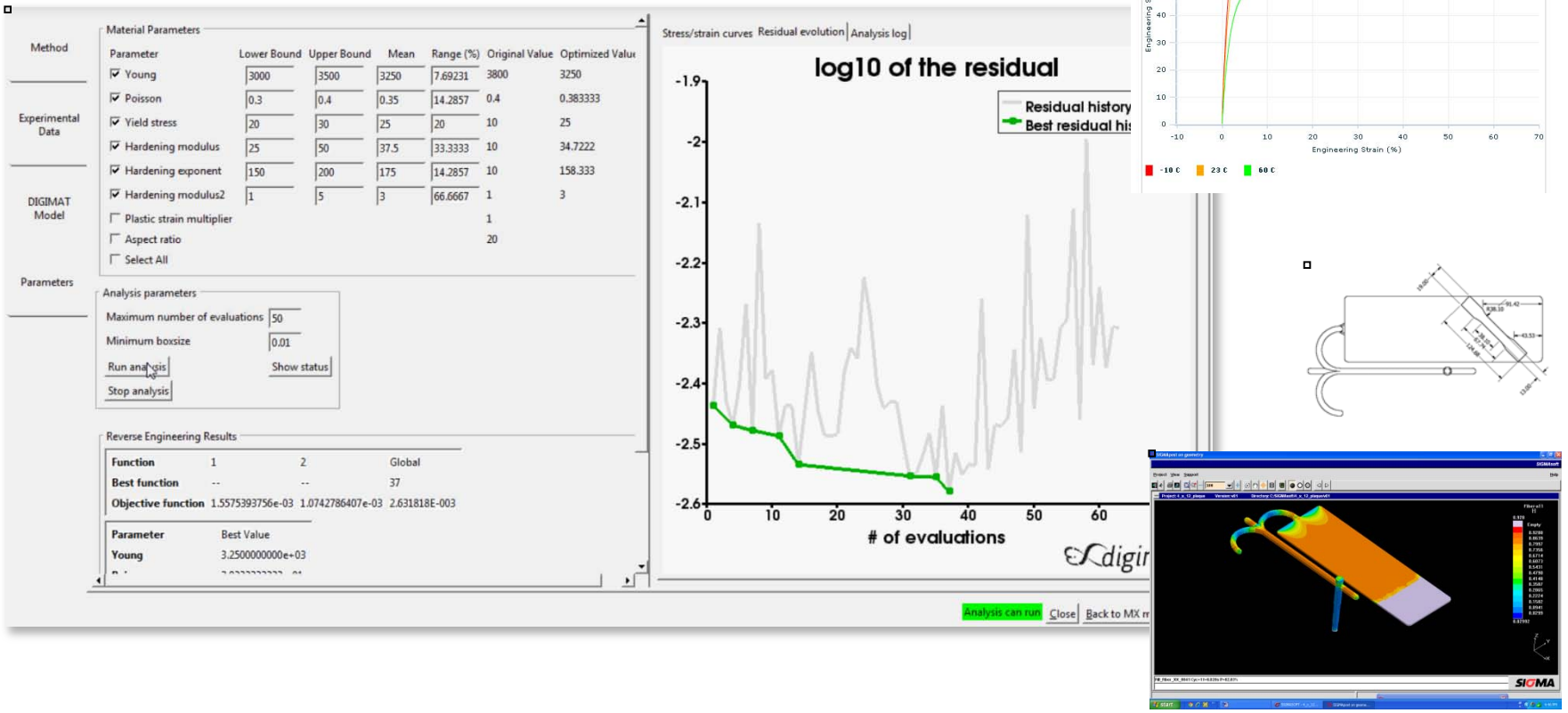


Image courtesy Sigmasoft (2011)

NEW DIGIMAT MX Reverse Engineering Service

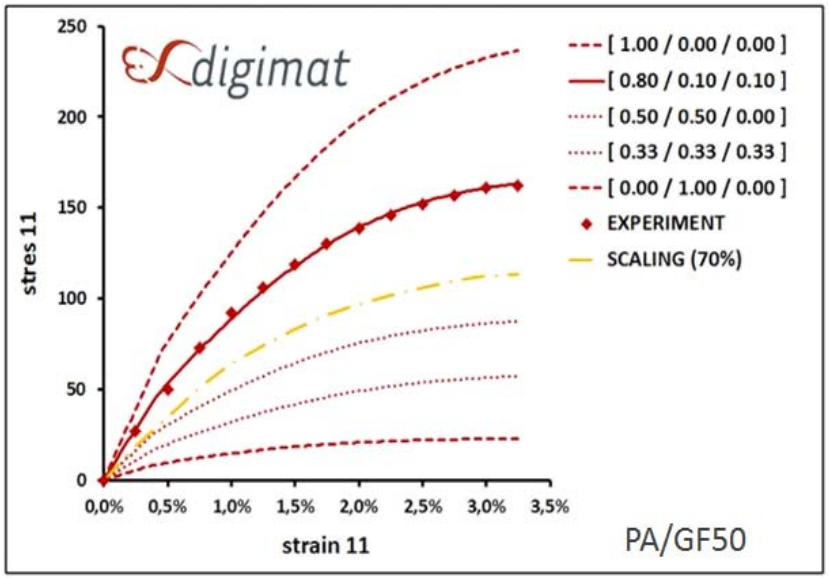
- Simulation-ready data delivered to client

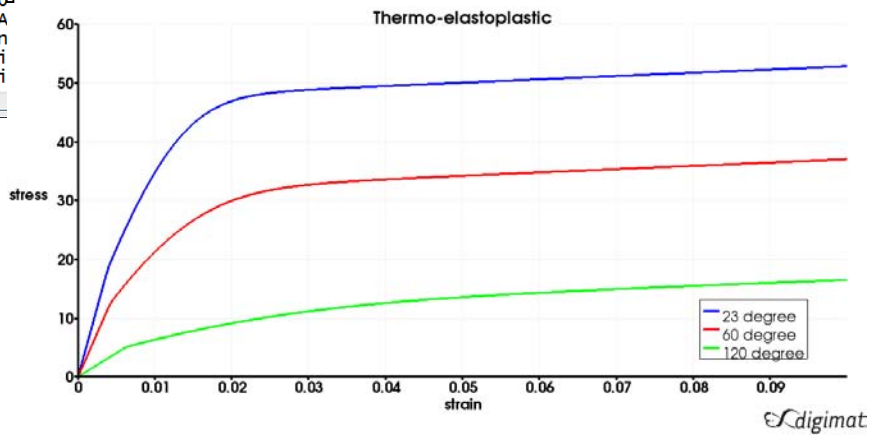
ThermoElastoPlastic.daf - Notepad

File Edit Format View Help

```
########################################
MATERIAL
name = Glass
type = elastic
density = 2.540000000000000e-009
Young = 7.200000000000000e+004
Poisson = 2.200000000000000e-001
thermal_expansion = 0.000000000000000e+000
reference_temperature = 2.300000000000000e+001

########################################
MATERIAL
name = PA6
type = J2_thermoplasticity
density = 1.130000000000000e-009
consistent_tangent = on
Young = 1.000000000000000e+003
Poisson = 4.000000000000000e-001
Young_dependence = youngPA6,temperature
yield_stress = 1.000000000000000e+000
hardening_model = exponential_linear
hardening_modulus = 1.000000000000000e+000
hardening_exponent = 1.000000000000000e+000
hardening_modulus2 = 1.000000000000000e+000
isotropic_method = spectral
thermal_expansion = 0.000000000000000e+000
reference_temperature = 2.300000000000000e+001
yield_stress_dependence = yieldStressPA
hardening_modulus_dependence = hardenin
hardening_exponent_dependence = hardeni
hardening_modulus2_dependence = hardeni
```





NEW Process with Reverse Engineering

Performed by e-Xstream engineering

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- Ship one 25kg bag of material
  - ✓ DHL pick-up service
- One week for molding
- One week for testing
- One week for reverse engineering
- DIGIMAT ready data delivered via Internet
  - ✓ Pdf test report
  - ✓ Raw digital data to client material database at www.matereality.com
  - ✓ DIGIMAT-ready data file

THANK YOU FOR YOUR ATTENTION

ANY QUESTION?

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