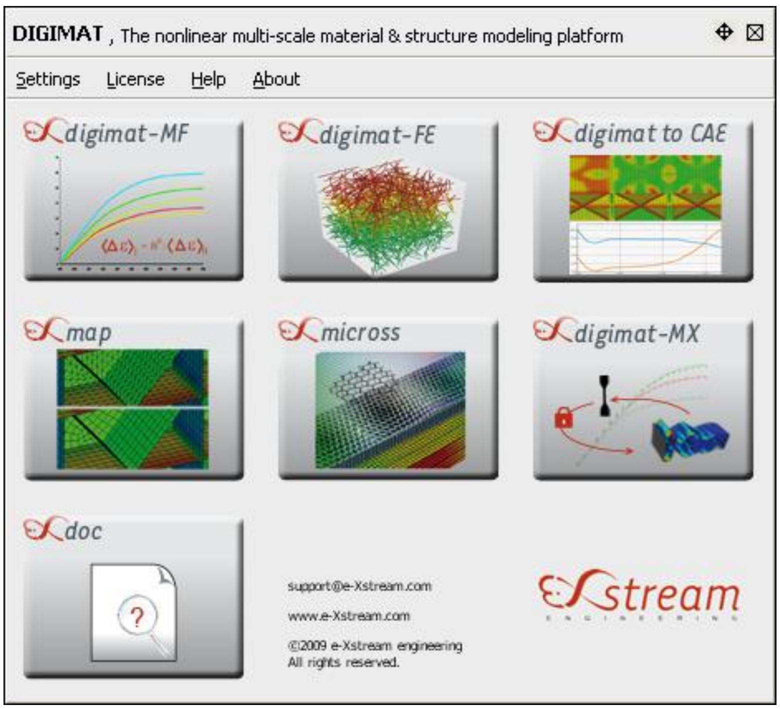
Release Notes: DIGIMAT 4.0.1 – January 2010



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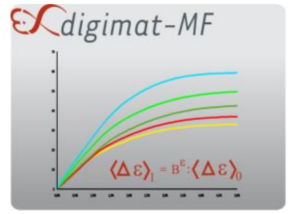


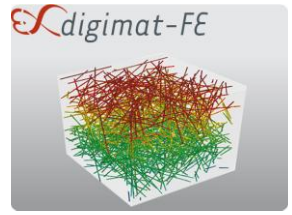
Digimat-MF

The Mean-Field homogenization software used to predict the multi-physics, nonlinear behavior of multi-phase materials.

New Capabilities in 4.0

- Viscoelastic-viscoplastic material model: This model couples the modeling capabilities of the linear viscoelastic and viscoplastic materials laws. It enables to capture the strain rate sensitivity of materials both in their elastic and plastic regimes.
- New closure and orientation distribution reconstruction method: This includes the fitted orthotropic closure approximation as well as an original reconstruction method of the orientation distribution function.
- Loading definition through piece-wise linear functions: While defining loadings, the user can define and assign piece-wise linear functions to the driving strain components. This extend the existing monotonic and cyclic (saw tooth) history loadings to general, user-defined, time histories.
- General 2D and 3D loadings: In addition to the predefined strain loadings (*i.e.* uniaxial, biaxial, ...), general loadings allow the user to define the driving strain components of his/her choice, their respective amplitudes and time histories.
- Loading definition extraction from FEA: Strain loading amplitudes and history functions can directly be defined by selecting an element in an Abaqus ODB and extracting his strain history. This selection can be made from Digimat-MF or from its plug-in interface to Abaqus/CAE.
- FPGF for multi-layered microstructure: The First Pseudo-Grain Failure model is extended to multi-layer microstructure allowing the monitoring of pseudo-grain failures at the composite layer level.
- Query material from Digimat-MX: DIGIMAT material models and analyses can be imported from Digimat-MX by querying one of its databases.
- Handling of encrypted material files: Encrypted material files can be exported from Digimat-MX in order to protect the material model definition and use it in Digimat-MF similarly to non-encrypted material models. An expiration date can also be attributed to encrypted material models, to control their period of use.
- Failure indicators for finite strain analyses: Maximum strain and maximum stress failure indicators can now be used in analyses involving finite strain (*i.e.* using hyperelastic or Leonov-EGP material models). These failure indicators are respectively based on Green-Lagrange strains and Cauchy stresses.
- Curve plotting tool improvements: The Digimat-MF post-processor is improved in order to better handle range and axis ticks definition. A dynamic zoom is also available by using the mouse wheel.

Digimat-FE

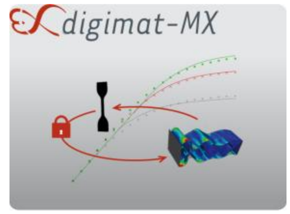


The Finite Element based homogenization software used to model the multi-physics, nonlinear behavior of Representative Volume Elements (RVE) of realistic material microstructures.

New Capabilities in 4.0

- Filler-Matrix debonding: Surface or continuum cohesive elements can be defined at matrix-filler interfaces and assigned their own traction-separation laws in order to model debonding.
- New orientation distribution reconstruction method: An original reconstruction method of the orientation distribution function is available in Digimat-FE allowing a more accurate reproduction of targeted microstructures in terms of filler orientation.
- Loading definition through piece-wise linear functions: While defining, loadings the user can define and assign piece-wise linear functions to the driving strain components. This extend the existing monotonic and cyclic history loadings to general, user defined, time histories.
- General 2D and 3D loadings: In addition to the predefined strain loadings (*i.e.* uniaxial, biaxial, ...), general loadings allow the user to select the driving strain components of his choice, their respective amplitudes and time histories.
- Loading definition extraction from FEA: Strain loading amplitudes and history functions can directly be defined by selecting an element in an Abaqus ODB and extracting its strain history. This selection can be made from Digimat-FE or from its plug-in interface to Abaqus/CAE.
- Computation of the percolation threshold: Digimat-FE can detect the existence of a percolation path between opposite faces of a RVE. This allows to estimate the filler volume fraction at which percolation occurs in order, for example, to feed percolation material models such as the one available in Digimat-MF.
- Single analysis file grouping all material and geometry files: All material and geometry files created by Digimat-FE can be saved in a unique archive file simplifying their storage and use.
- Transversely isotropic ohm material: Such material model can be defined at phase level when performing electrical analysis.
- CPU improvement: Digimat-FE microstructure generation process is optimized for a faster RVE generation.
- Restart: Microstructure creation can be restarted from a partially generated microstructure allowing the user to adapt Digimat-FE parameters in-between two generation phases.
- Curve plotting tool improvements: Digimat-FE post-processor is improved in order to better handle range and axis ticks definition. A dynamic zoom is also available by using the mouse wheel.

Digimat-MX

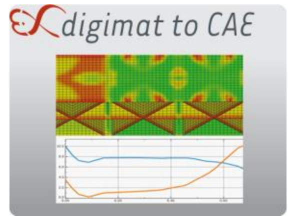


The Material eXpert system is used to prepare, to store & retrieve and to securely exchange DIGIMAT material models between material suppliers and end-users, while protecting the Intellectual Property of the involved parties.

New Capabilities in 4.0

- Management of DIGIMAT material models and experimental data: Digimat-MX aims at allowing users to manage their Digimat material models as well their experimental data by storing them in databases. Storage follows the corresponding characteristics of these data (test temperature, material model behavior, strain rate, humidity, ...) in order to parse and query them easily. Digimat-MX also gives access to such data through its public database which already contains various DIGIMAT material models and experimental data coming from several material suppliers.
- Parameter identification: This capability allows the user to identify parameters of homogeneous material models. Currently supported material behaviors encompass elasticity, plasticity, viscoplasticity as well as viscoelasticity.
- Reverse engineering: This procedure has the aim of computing, by an optimization process, the best set of parameters of a selected material model in order to reproduce the material behaviors exhibited by a set of experimental data. This set of data can be made of stress-strain curves at different strain rates or obtained for different loading angles. Currently supported material behaviors encompass elasticity, plasticity, viscoplasticity as well as viscoelasticity
- Encryption of material models: Digimat-MX allows the encryption and the export of any material model in order to protect the IP attached to the model parameters. Encrypted material models can also be attributed an expiration date to control their period of use.
- Multiple databases and multiple users: Digimat-MX can handle simultaneously different databases and users. By default, the Digimat-MX cluster of databases is made of four databases, namely:
    - MXDB: The public database which contains DIGIMAT material models and experimental data.
    - EDB: A database aiming at containing data that can be Externalized by the user.
    - IDB: A database aiming at containing data that are prepared for Internal use.
    - WDB: A database which can be used as a Working database.
- Link with other products: Material models stored in Digimat-MX can be automatically imported in Digimat-MF, Digimat-FE or Digimat to CAE. This import operation can be triggered both from Digimat-MX or from Digimat-MF, Digimat-FE or Digimat to CAE.

Digimat to CAE

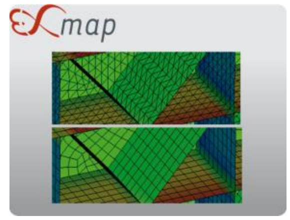


DIGIMAT linear and nonlinear interfaces to major injection molding and structural FEA software to enable seamless multi-scale analyses of composite materials and structures.

New Capabilities in 4.0

- Digimat to RADIOSS: Digimat-MF interface to RADIOSS (explicit solver - version 10.0.2) enables nonlinear multi-scale analyses under Windows and Linux platforms. This interface supports small strain material models available in Digimat-MF and can use DMP parallel processing under Linux 64 bits.
- Digimat to 3D Timon: Fiber orientation tensors predicted by the 3D Timon injection code can be used in Digimat to CAE when performing FEA involving 3D continuum elements.
- DMP version of the Digimat to PAM-Crash: Digimat to PAM-Crash is available on Linux 64 bit platforms and allows DMP parallel computation using MPI.
- Generation of stiffness files during structural FEA: Tangent stiffness tensors, as well as thermal expansion matrices, can be exported at a given time or increment during either explicit or implicit FEA. The exported data can be visualized on the FE mesh using Map.
- Thermo-Elastic weakly coupled multi-scale analyses: Weak coupling computation (*i.e.* not performing homogenization tasks at run-time) can be performed using Digimat to CAE. This is done in a two-step process. During the first step one can export the thermo-elastic stiffness for every elements of the target mesh. During the second step, the exported stiffness is used to perform a linear FEA.
- Improvements of Abaqus/CAE plug-in: Digimat to Abaqus/CAE plugin interface is improved in order to allow the user to tune its Digimat to CAE analysis from the plug-in. The plug-in is enhanced in order to allow the user to query Digimat-MF material models available in Digimat-MX databases.
- Support of Abaqus 6.9: Digimat to Abaqus/Standard and Abaqus/Explicit interfaces support release 6.9 of Abaqus.
- Query material from Digimat-MX: Digimat-MX can be queried from Digimat to CAE to import Digimat-MF material models. The user can assign fiber orientation or define specific integration parameters before running his/her FEA.

Map

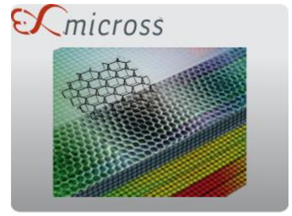


Shell & 3D mapping software used to transfer fiber orientation, residual stresses, temperatures and weldlines between dissimilar injection molding and structural FEA meshes.

New Capabilities in 4.0

- Cut in 3D mesh: This capability allows the user to place a cut plane by driving its position and orientation in order to visualize the data under consideration in the core of the mesh.
- Through-the-thickness orientation plot for shell elements: The through-the-thickness 2D plot of any component of an orientation tensor can be displayed by picking the desired shell element in the current mesh.
- Display tensor fields using ellipsoids: Ellipsoids can be displayed instead of arrows when visualizing vector plots. The ellipsoid shape aspect ratios are scaled by the eigenvalues, and are aligned parallel to the eigenvectors, of the local orientation tensors.
- Handling of mesh translucency: Mesh translucency can be tuned from fully opaque (default) to fully transparent allowing the user to visualize arrows or ellipsoids from vector plots in the bulk of a part.
- Display superposition of donor and receiver meshes: This capability allows the user to display in the same frame the selected donor and receiver meshes. Mesh translucency can be selectively and independently adapted for any mesh when using this capability.
- Improved display and loading of large FE models: CPU and memory optimizations were performed in order to lower the CPU time needed to load and display large FE meshes.
- Display of material properties using stiffness material file: Stiffness data exported from Digimat to CAE can be visualized in Map allowing the user to display local equivalent isotropic modules, the anisotropy measure or apparent modules.
- Mapping of Moldflow/Midplane and 3D Timon weld lines: Weld line data can be mapped from Moldflow mid-plane or 3D Timon meshes to a receiver mesh in order to indentify the structural elements containing weld line nodes.
- Selective display of element sets: Element sets can be selectively displayed when visualizing a mesh. Element sets are imported from parts, groups or element sets definitions (when available and supported) present in the loaded mesh file. Element sets are also created when performing mapping in order to identify more easily the zones facing mapping issues.
- Interface to 3D Timon: Map allows to load 3D Timon orientation files (for continuum elements), temperature fields and weld line definitions and to use them in any mapping process. Map also allows loading 3D Timon mesh in original or IDEAS format.
- Interface to RADIOSS: RADIOSS mesh file can be imported in Map and used as any other mesh definition when performing mapping.

Micross



Micross is the accurate and easy-to-use software used to develop composite sandwich panels using standard numerical bending and shear tests. Material can be input at the Composite/Core (macro) level or at the Fiber-Resin/Cell level. Micross can be used by analysts and designers with no experience in micromechanics or finite element modeling.

New Capabilities in 4.0

No new capabilities.

Doc

DIGIMAT Users' Manual. It contains all the technical information about the DIGIMAT software modules as well as practical information about their use. Tutorials and hands-on exercises are also provided for the user to get familiar with the software.

New Capabilities in 4.0

Version 4.0 of the users' manual has been strongly enhanced. Significant efforts in improving both its content and format have been done.

- Technical information have been added to the manual. In particular, a section dedicated to the mean-field homogenization technique is now available in the manual of Digimat-MF, as well as more detailed descriptions of the material models available in DIGIMAT.
- Readability has been improved via a standardization of the manual format.
- Each documentation page is now accessible either via the navigation menu or via the Keyword list page to ease the access to pertinent information.

The effort for a better documentation is still on-going and future releases will see new improvements coming in the manual.