# PolyUMod Material Database

The PolyUMod Material Database is a set of pre-calibrated material models. The already calibrated material models are intended to be used as ‘generic’ models for specific polymers, instead of using, for example, the elastic modulus and Poisson’s ratio from a specification sheet. This means that the behavior of the library model will likely not be an exact match for the behavior of your material due to variability in additives and processing conditions. However, the models have been calibrated to extensive test data and should provide significantly more accurate results than a model based on manufacturer data sheets.

The PolyUMod Material Database is a set of pre-calibrated material models for common rubbers and plastics. The database is included with all PolyUMod licenses, and can be used with Abaqus, Ansys Mechanical, LS-DYNA, COMSOL Multiphysics, Altair Radioss™, and MSC. Marc.

All material models in the database are strain-rate dependent viscoplastic models that require non-linear geometry (large deformations) to be activated in the FE simulation.

## Available Models

The PolyUMod Material Database contains the following pre-calibrated material models:

| Material Name | Description | PolyUMod Material ID | State Variable | Model |
|---|---|---|---|---|
| **ABS** | acrylonitrile butadiene styrene | 2004 | 23 | TN |
| **AM CE** | additive manufactured cyanate ester, temperature-dependent, isotropic | 2006 | 23 | TN |
| **AM PA11** | additive manufactured SLS polyamide 11, isotropic | 2005 | 23 | TN |
| **AM PA12** | additive manufactured SLS polyamide 12, anisotropic, build direction is the 1 direction | 2008 | 14 | ABBM |
| **AM PU** | additive manufactured DLS polyurethane, isotropic | 2007 | 23 | TN |
| **EPDM** | ethylene propylene diene monomer rubber, recommended JAC=3 | 2021 | 43 | TNV |
| **GF PA 66** | polyamide (nylon) 66, 30% glass fiber filled, anitropic, fibers aligned in the 2-direction | 2013 | 68 | FEN |
| **GF PEI** | polyetherimide, 30% glass fiber filled, anisotropic, fibers aligned in the 1-direction | 2011 | 68 | FEN |
| **HDPE** | high density polyethylene | 2003 | 23 | TN |
| **LLDPE** | linear low density polyethylene, recommended JAC=3 | 2022 | 43 | TNV |
| **PTFE** | polytetrafluoroethylene | 2001 | 23 | TN |
| **PA 66** | polyamide (nylon) 66 | 2012 | 23 | TN |
| **PC** | polycarbonate | 2014 | 23 | TN |
| **PEEK** | polyether ether ketone, all strain rates | 2016 | 23 | TN |
| **PEEK** | polyether ether ketone, low strain rates | 2015 | 23 | TN |
| **PEEK** | polyether ether ketone, different temperatures | 2017 | 23 | TN |
| **PEI** | polyetherimide, all strain rates | 2010 | 23 | TN |
| **PEI** | polyetherimide, low strain rates | 2009 | 23 | TN |
| **PET** | polyethylene terephthalate | 2002 | 13 | A2N |
| **PLLA** | poly-L-lactide, anisotropic, stiffest in the 1-direction | 2018 | 68 | FEN |
| **PP** | polypropylene, recommended JAC=3 | 2020 | 43 | TNV |
| **Silicone** | silicone rubber, shore 55A, recommend JAC=3 | 2019 | 43 | TNV |

## Instructions

The database material models are specified using 5 parameters:

1. MM, the material ID
2. Units, the units system to use, see table below
3. ODE, ODE solver type. The default value is 0. For more information see the PolyUMod User's Manual.
4. JAC. Jacobian solver type. The default value is 0. For more information see the PolyUMod User's Manual.
5. TWOD_S. Plane stress flag. The default value is 0. For more information see the PolyUMod User's Manual.

The material models are provided in the following unit systems.

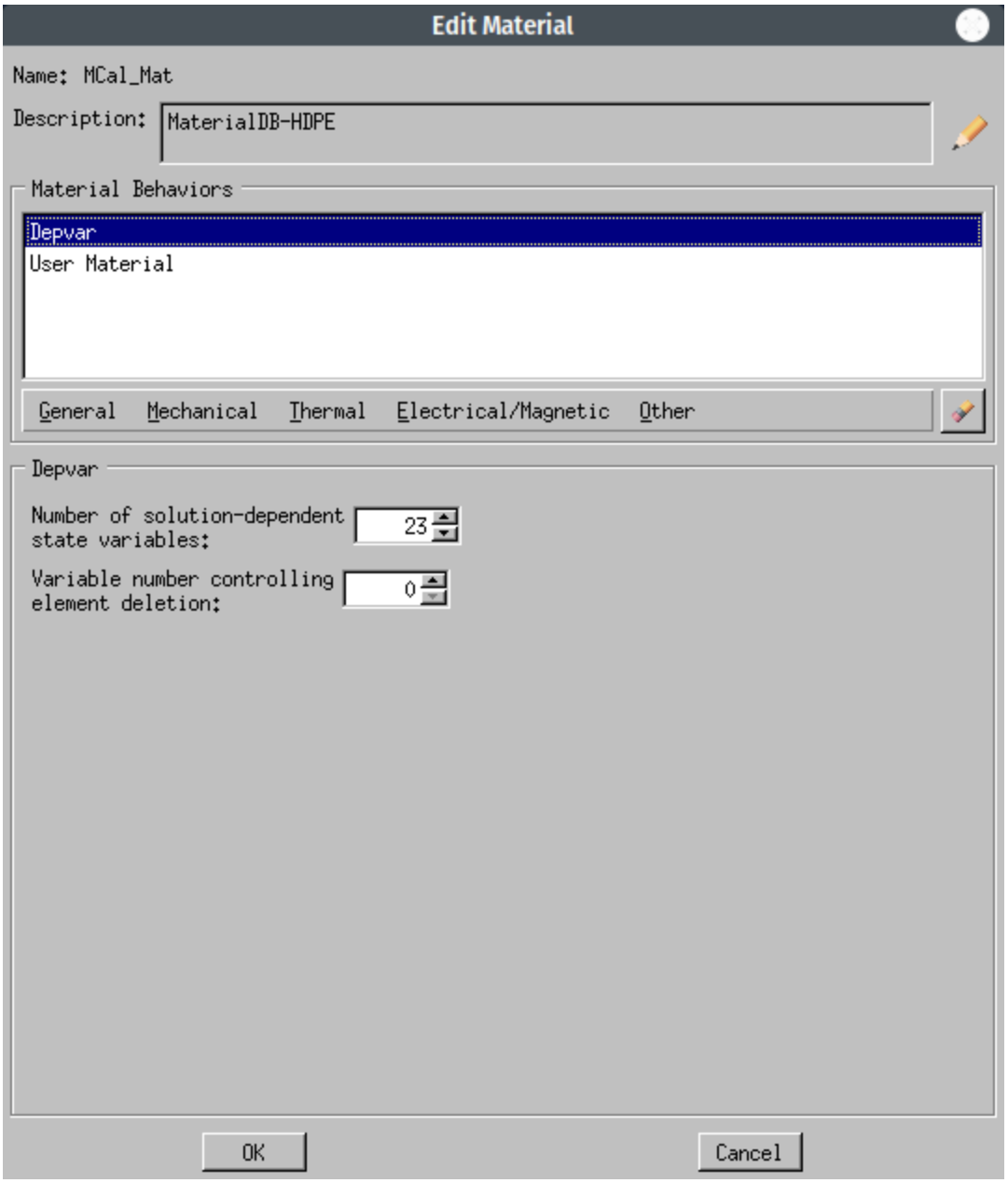
| Unit ID | Force Unit | Length Unit | Time Unit | Temperature Unit |
|---|---|---|---|---|
| **1** | N | m | s | K |
| **2** | N | mm | s | K |
| **3** | N | mm | ms | K |
| **4** | lbf | in | s | R |

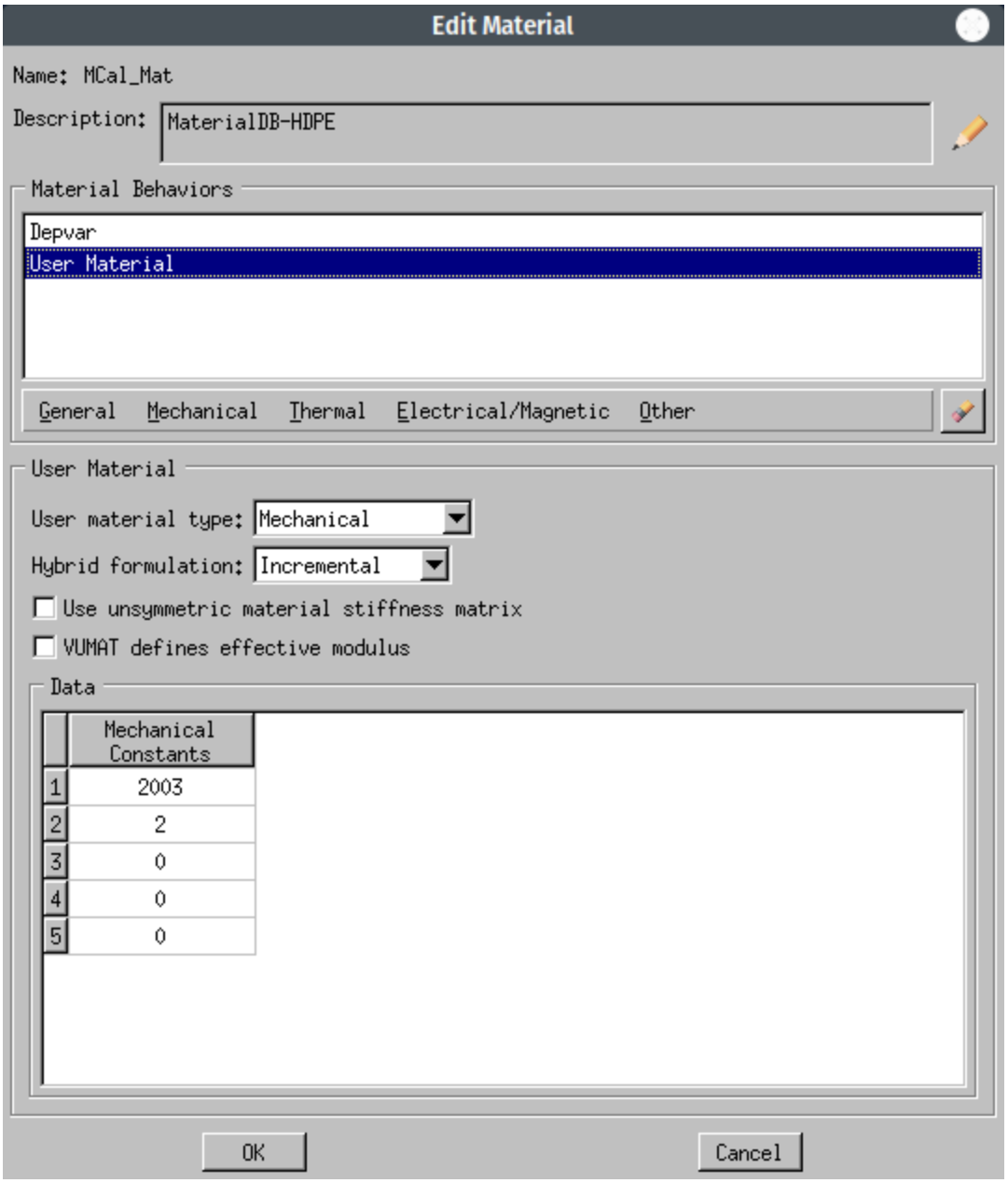
In addition, the material models also need the number of state variables that are listed in the table above. Note that LS-DYNA simulations require an additional 9 state variables than the values listed in the table.

## Abaqus Input File Example

```
*Material, name=Mat_PTFE
*User Material, constants=5
** MM, Units, ODE, JAC, TWOD_S
 2001,    1,  0,  0,     0
*Depvar
23
*Density
1000
```

Here is an example of how you can specify a material database model in Abaqus/CAE. This example is for HDPE (id=2003) and is using 23 state variables.


Edit Material
Name: MCal_Mat
Description: MaterialDB-HDPE
Material Behaviors
Depvar
User Material
General
Mechanical
Thermal
Electrical/Magnetic
Other
Depvar
Number of solution-dependent state variables:
23
Variable number controlling element deletion:
0
OK
Cancel


Edit Material
Name: MCal_Mat
Description: MaterialDB-HDPE
Material Behaviors
Depvar
User Material
General
Mechanical
Thermal
Electrical/Magnetic
Other
User Material
User material type: Mechanical
Hybrid formulation: Incremental
Use unsymmetric material stiffness matrix
VUMAT defines effective modulus
Data
Mechanical Constants
1 2003
2 2
3 0
4 0
5 0
OK
Cancel

## Ansys Input File Example

```
TB, USER, matid, 1, 5
TBDATA, 1, 2001 ! Material model number
TBDATA, 2, 1    ! Unit system used
TBDATA, 3, 0    ! ODE
TBDATA, 4, 0    ! JAC
TBDATA, 5, 0    ! TWOD_S
! State variables
TB, STATE, matid, 1, 23
! Density
MP, DENS, matid, 1000
```

## LS-DYNA Input File Example

```
*MAT_USER_DEFINED_MATERIAL_MODELS +
$ mid,   ro, mt, lmc, nhv, iortho, ibulk, ig
   1, 1000, 45,   5,  32,     0,    6,  7
$ ivect, ifail, it, ihyper, ieos, lmca
     0,    1,  1,      1,   0,    0
$ MM, units, ODE, JAC, TWOD_S,  bulk,    ig
2001,     1,   0,   0,     0, 500.0, 100.0
```

## COMSOL Input File Example

```
{2001, 2, 0, 0, 0}
```

## MSC.Marc Input File Example

```
$------------------
$ Parameter Section
$------------------
state vars, 23, 0
$
$-------------------------
$ Model Definition Section
$-------------------------
MATUDS
$ (subName, matid, notUsed, nrInt, nrReal, nrChar)
hypela2, 1, 0, 0, 2, 0
2001, 2,0,0,0
```