# Operator DEFI_COMPOR

## 1 Drank

To define the behavior of a monocrystal, a polycrystal or a beam multifibers.

For the behavior of a monocrystal or a polycrystal, one allows the user to choose the components of the single-crystal constitutive law.

One gives, according to this definition, only the name of crystallographic structure, knowing that the directions of sliding systems of each family of sliding systems are defined once and for all in the code-source.

In the case of a beam multifibers, this operator makes it possible to associate with a group of fibers an incremental behavior.

## 2 Syntax

```
Comp1 [compor] = DEFI_COMPOR (
♦/MONOCRISTAL     =   (
      _F (♦MATER=   mat1,                                       [to subdue]
         ♦ELAS=/                 "ELAS"
                              /"ELAS_ORTH"
         ♦/  ECOULEMENT =      "MONO_VISC1"
                                 /"MONO_VISC2"
                     ♦ECRO_ISOT=/        "MONO_ISOT1"
                                         /"MONO_ISOT2"
                     ♦ECRO_CINE=/        "MONO_CINE1"
                                         /"MONO_CINE2"
                     ♦   FAMI_SYST_GLIS =  "OCTAEDRIQUE",
                                         /"CUBIQUE1",
                                         /"CUBIQUE2",
                                         /"BCC24",
                                         /"ZIRCONIUM",
                                         /"UNIAXIAL",
            /ECOULEMENT = "MONO_DD_KR"
                      ♦ FAMI_SYST_GLIS =  "BCC24",
            /ECOULEMENT = "MONO_DD_CFC"
                      ♦ FAMI_SYST_GLIS =  "OCTAEDRIQUE",
            /ECOULEMENT = "MONO_DD_CFC_IRRA"
                      ♦ FAMI_SYST_GLIS =  "OCTAEDRIQUE",
            /ECOULEMENT = "MONO_DD_FAT"
                      ♦ FAMI_SYST_GLIS =  "OCTAEDRIQUE",
            /ECOULEMENT = "MONO_DD_CC"
                      ♦ FAMI_SYST_GLIS =  "CUBIQUE1",
            /ECOULEMENT = "MONO_DD_CC_IRRA"
                      ♦ FAMI_SYST_GLIS =  "CUBIQUE1",

            ◊ TABL_SYST_GLIS= tabsys,                        [array]
      ),
                     ),

      ◊ MATR_INTER=tabinter                                  [array]

      ◊ ROTA_RESEAU =   "NON"                             [DEFAULT]
                     /"POST"
                     /"CALC"

   /POLYCRISTAL  =   (

         _F (   ♦MONOCRISTAL=        comp1,                  [compor]
            ♦FRAC_VOL=               fvol,               [R]
            ♦/     ANGL_REP=      (has, B, c)                [l_R]
               /ANGL_EULER       = (phi1, phi, phi2),        [l_R] )),

         ◊LOCALIZATION =      "BZ",
                           /   "BETA",
                                 ♦DL=       dl,          [R]
                                 ♦DA=       da,          [R]

   /MULTIFIBRE    =   (
         _F (   ♦GROUP_FIBER    = liste_group_fibres,     [l_TXM]
            ♦MATER=mat1                  ,                   [to subdue]
               ◊   RELATION =   |(see the document [U4.51.11]),
```

```
                ◊RELATION_KIT=/           "VMIS_ISOT_TRAC",
                              /  "VMIS_ISOT_LINE",
                              /  "VMIS_ISOT_CINE",
                              /  "VMIS_ISOT_PUIS",
                              /  "GRANGER_FP",
                              /  "GRANGER_FP_INDT",
                              /  "GRANGER_FP_V",
                              /  "BETON_UMLV_FP",
                              /  "ROUSS_PR",
                              /  "BETON_DOUBLE_DP",)),

   # concept gathering the groups of fibers (resulting from
DEFI_GEOM_FIBRE)
   ◊GEOM_FIBER=     gfibre,                [gfibre]
   #  material for the characteristics homogenized on section
   ◊MATER_SECT=     MATER,                 [to subdue]
    ));
```

# 3 Operands

## 3.1 Key word MONOCRISTAL

an occurrence of the key word factor MONOCRISTAL makes it possible to define a single-crystal elastoviscoplastic constitutive law. This is to be repeated as many times as one has different single-crystal constitutive laws [R5.03.11].

### 3.1.1 Operand MATER

Defines the name of the material produced by DEFI_MATERIAU used for the monocrystal. This operand makes it possible to check that the parameters associated with the behaviors chosen under key words ECOULEMENT, ECRO_ISOT, ECRO_CINE and ELAS exist well in the material.

### 3.1.2 Operand ECOULEMENT

Defines the viscoplastic type of flow used in the definition of constitutive law MONOCRISTAL.

### 3.1.3 Operand ECRO_ISOT

Defines the isotropic type of hardening used in the definition of constitutive law MONOCRISTAL.

### 3.1.4 Operand ECRO_CINE

Defines the type of kinematic hardening used in the definition of constitutive law MONOCRISTAL.

### 3.1.5 Operand ELAS

Defines the type of the elastic behavior used in the definition of constitutive law MONOCRISTAL.

### 3.1.6 Operand FAMI_SYST_GLIS

Defines the surname of sliding systems on whom one defined constitutive law MONOCRISTAL. The directional senses of the norms to the slip surfaces and the directions of sliding are calculated automatically by the code starting from the surname.

### 3.1.7 Operand TABL_SYST_GLIS

Makes it possible sliding systems to provide a family of “user”, read in an array. One must give for each line array (corresponding with a system of sliding) the 3 components in the reference of the crystal of the vectors $\boldsymbol{n}$ (norm with the slip surface) and $\boldsymbol{m}$ (direction of sliding). Example (see also the test `ssnd112c`):

$$n_x(s_1), n_y(s_1), n_z(s_1), m_x(s_1), m_y(s_1), m_z(s_1)$$
$$n_x(s_2), n_y(s_2), n_z(s_2), m_x(s_2), m_y(s_2), m_z(s_2)$$
$$etc...$$

**Limitations** : this functionality is active only for behavior `MONOCRISTAL`, and on condition that defining only one family of systems (only one occurrence of `MONOCRISTAL`). It is not available for behavior `POLYCRISTAL`.

### 3.1.8 Operand MATR_INTER

Makes it possible to provide a matrix of interaction (single) between sliding systems of a monocrystal, read in an array. It is a square, symmetric table of dimension the number of sliding systems total. Example (see also the test `ssnd112c`):

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 0,124 | 0,124 | 0,124 | 0,625 | 0,137 | 0,137 | 0,137 | 0,122 | 0,070 | 0,137 | 0,070 | 0,122 |
| 0,124 | 0,124 | 0,124 | 0,137 | 0,070 | 0,122 | 0,625 | 0,137 | 0,137 | 0,137 | 0,122 | 0,070 |
| 0,124 | 0,124 | 0,124 | 0,137 | 0,122 | 0,070 | 0,137 | 0,070 | 0,122 | 0,625 | 0,137 | 0,137 |
| 0,625 | 0,137 | 0,137 | 0,124 | 0,124 | 0,124 | 0,122 | 0,137 | 0,070 | 0,122 | 0,070 | 0,137 |
| 0,137 | 0,070 | 0,122 | 0,124 | 0,124 | 0,124 | 0,070 | 0,137 | 0,122 | 0,137 | 0,137 | 0,625 |
| 0,137 | 0,122 | 0,070 | 0,124 | 0,124 | 0,124 | 0,137 | 0,625 | 0,137 | 0,070 | 0,122 | 0,137 |
| 0,137 | 0,625 | 0,137 | 0,122 | 0,070 | 0,137 | 0,124 | 0,124 | 0,124 | 0,122 | 0,137 | 0,070 |
| 0,122 | 0,137 | 0,070 | 0,137 | 0,137 | 0,625 | 0,124 | 0,124 | 0,124 | 0,070 | 0,137 | 0,122 |
| 0,070 | 0,137 | 0,122 | 0,070 | 0,122 | 0,137 | 0,124 | 0,124 | 0,124 | 0,137 | 0,625 | 0,137 |
| 0,137 | 0,137 | 0,625 | 0,122 | 0,137 | 0,070 | 0,122 | 0,070 | 0,137 | 0,124 | 0,124 | 0,124 |
| 0,070 | 0,122 | 0,137 | 0,070 | 0,137 | 0,122 | 0,137 | 0,137 | 0,625 | 0,124 | 0,124 | 0,124 |
| 0,122 | 0,070 | 0,137 | 0,137 | 0,625 | 0,137 | 0,070 | 0,122 | 0,137 | 0,124 | 0,124 | 0,124 |

**Limitations** : this functionality is active for behavior `MONOCRISTAL` and behavior `POLYCRISTAL`, on condition that using one type of `MONOCRISTAL`).

### 3.1.9 Operand ROTA_RESEAU

- `ROTA_RESEAU=' CALC'` makes it possible to calculate the rotation of the crystal lattice and to take it into account in the resolution of constitutive law `MONOCRISTAL`, into implicit only. The directional senses of the norms to the slip surfaces and the directions of sliding are put up to date automatically by the code at every moment of computation, and the corresponding local variables are added (see their meaning in [R5.03.11].
- `ROTA_RESEAU=' POST'` makes it possible to calculate the rotation of the crystal lattice, without taking it into account in the resolution, and to display the values in the local variables, has ends of postprocessings.

**Validity and limitations:**
This approximation is to be used in the presence of small strains `DEFORMATION=' PETIT'` under `COMP_INCR`, for `RELATION=' MONOCRISTAL'` [U4.51.11]. It must be thus used for moderate strains (about 10% at the most). Beyond that, and for a complete taking into account of the large deformations, it is necessary to use an adapted resolution, without using key word `ROTA_RESEAU` : `DEFORMATION=' SIMO_MIEHE'` in `STAT_NON_LINE/COMP_INCR`.

## 3.2 Key word POLYCRISTAL

an occurrence of the key word factor POLYCRISTAL makes it possible to define a phase of the polycrystalline behavior, from the data of a single-crystal behavior, voluminal fraction of this phase, and directional sense of this phase. This is to be repeated as many times as one has different single-crystal phases. Moreover, one rule of localization, commune to all the phases, is defined by the key word LOCALIZATION [R5.03.11].

### 3.2.1 Operand MONOCRISTAL

Defines the name of the SD compor defining the monocrystal, produced by a call former to DEFI_COMPOR.

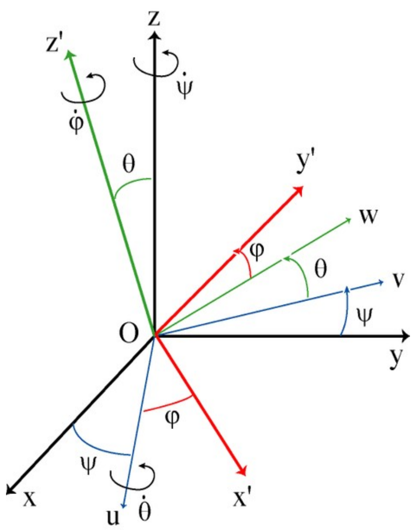
### 3.2.2 Operand FRAC_VOL

Defines the voluminal fraction of the phase in progress. The sum of all the values of fvol must be equal to 1.

### 3.2.3 Operand ANGL_REP/ANGL_EULER

Defines the 3 nautical angles (provided in degrees) [U4.42.01] or the 3 Eulerian angles (provided in degrees) which make it possible to direct the monocrystal corresponding to the phase defined by the current occurrence of POLYCRISTAL. The Eulerian angles are defined in a conventional way: one passes from the fixed reference frame $Oxyz$ to the reference frame related to solid $Ox'y'z'$ by three successive rotations.

1) The precession $\psi$, around the axis $Oz$, makes pass from $Oxyz$ to the reference frame $Ouvz$.
2) Nutation $\theta$, around the axis Or, makes pass from $Ouvz$ to $Ouwz'$.
3) Clean rotation $\varphi$, around the axis $Oz'$, makes pass from $Ouwz'$ to the reference frame related to solid $Ox'y'z'$.




## 3.3 Key word LOCALIZATION

Defines the name of the rule of localization used for the polycrystal.

### 3.3.1 Operands DL and DA

If the rule of localization is "BETA", two real parameters should be provided: dl and da. The rule of localization is in [R5.03.11].

## 3.4 Key word MULTIFIBRE

This key word makes it possible to associate with a group of fibers an incremental behavior.

```
_F (   ♦GROUP_FIBER  = liste_group_fibres                  [l_TXM]
   ♦MATER=mat1                                             [to subdue]
   ♦RELATION  incremental  =/relations available for the multifibre beams
                          /…
   ◊RELATION_KIT=/relations        available for the multifibre beams
                          /…
   )
```

### 3.4.1 Operand GROUP_FIBRE

Makes it possible to define, for each occurrence of factor key word the MULTIFIBRE, the names of the groups of fibers associated with the selected behavior model. These groups of fibers were as a preliminary defined by the command DEFI_GEOM_FIBRE, of which the resulting concept is specified by the key word GEOM_FIBRE below.

### 3.4.2 Operand MATER

This key word makes it possible to specify the name of the material containing the parameters associated with the selected behavior.

### 3.4.3 Operands RELATION/RELATION_KIT

These keys key make it possible to define the behavior model (possibly in form "KIT_DDI ") associated with the groups of fibers defined by GROUP_FIBRE. The behavior models are described in [U4.51.11]. Let us announce however that the list of the behaviors usable with the multifibre beams is restricted compared to [U4.51.11].

### 3.4.4 Notice on the behaviors 1D

the multifibre modelizations of beams (like those of bars, of grids of reinforcements) use for each fiber an one-way behavior. If the selected constitutive law is available in 1D, this integration directly is used. If not, the method of DEBORST generalized with the case of the behaviors 1D [R5.03.09] makes it possible to add the uniaxial constraint to all the behaviors available for the modelizations 3D under COMP_INCR (for more detail to see Doc. [R5.03.09]). The assumption of the uniaxial stresses is checked with convergence. One recommends to rather often use and reactualize the tangent matrix (all the one with three iterations) in the method of Newton (MATRICE = "TANGENT", REAC_ITER = 1 to 3).

## 3.5 Key word GEOM_FIBRE

This key word makes it possible to specify the name of the concept gathering the groups of fibers (resulting from DEFI_GEOM_FIBRE.

```
◊GEOM_FIBER=      gfibre        [gfibre_sdaster]
```

## 3.6 Key word MATER_SECT

Definition of the material containing (under key word ELAS) the homogenized elastic characteristics of the section, used in particular for the computation of the torsion stiffness.

```
◊MATER_SECT=      MATER     [mater_sdaster],));
```

## 3.7 Example

### 3.7.1 examples of use for the crystalline materials

the following example corresponds to a classical use of MONOCRISTAL. It is resulting from test SSNV171B:

```
ACIER=DEFI_MATERIAU (ELAS=_F (E=145200.0, NU=0.3,),
   MONO_VISC2=_F (  N=10.0,
                    K=40.0,
                    C=1.0,
                    D=36.68,
                    A=10.0,),
   MONO_ISOT2=_F (  R_0=75.5,
                    Q1=9.77,
                    B1=19.34,
                    H=0.5,
                    Q2=-33.27,
                    B2=5.345,),
   MONO_CINE1=_F (  D=36.68,),);

COMPORT=DEFI_COMPOR (MONOCRISTAL= (_F (MATER=ACIER, ELAS=' ELAS',
                       ECOULEMENT=' MONO_VISC2',
                       ECRO_ISOT=' MONO_ISOT2',
                       ECRO_CINE=' MONO_CINE1',
                       FAMI_SYST_GLIS=' OCTAEDRIQUE',),),),);
```

The following example, implementing POLYCRISTAL, is resulting from test SSNV171B:

```
MATPOLY=DEFI_MATERIAU (  ELAS=_F (E=192500.0, NU=0.3,),
  MONO_VISC2=_F (N=10.0,
    K=40.0,
    C=6333.0,
    D=36.68,
    A=72.21,),
  MONO_ISOT2=_F (R_0=75.5,
    Q1=9.77,
    B1=19.34,
    H=2.54,
    Q2=-33.27,
    B2=5.345,),
  MONO_CINE1=_F (D=36.68,),);

MONO1=DEFI_COMPOR (
  MONOCRISTAL=_F (MATER=MATPOLY,
     ECOULEMENT=' MONO_VISC2',
     ECRO_ISOT=' MONO_ISOT2',
     ECRO_CINE=' MONO_CINE1',
     ELAS=' ELAS',
     FAMI_SYST_GLIS=' OCTAEDRIQUE',),);

POLY1=DEFI_COMPOR (
  POLYCRISTAL= (
   _F (MONOCRISTAL=MONO1,
      FRAC_VOL=0.025,
      ANGL_REP= (- 149.67, 15.61, 154.67,),),
   _F (MONOCRISTAL=MONO1,
      FRAC_VOL=0.025,
```

```
        ANGL_REP= (- 481.7, 35.46, 188.7),),),
        LOCALIZATION=' BETA',
        DL=321.5,
        DA=0.216,);
```

### 3.7.2 Example of use for the multifibre beams

the commands below make it possible to illustrate the use of DEFI_COMPOR for a multifibre behavior (see for example test SSNL119A ):

```
GF=DEFI_GEOM_FIBER (    FIBER = (_F (GROUP_FIBRE=' SACI',
                                CARA = “DIAMETRE”,
                                COOR_AXE_POUTRE = (0. , 0. ,),
                                 VALE = ( 0.066, -0.218,32.E-3,
                                         0.066,-0.218,32.E-3,
                                         0.066,0.218,8.E-3,
                                         0.066,0.218,8.E-3,),),),
                        SECTION = _F (GROUP_FIBRE=' SBET',
                                   MAILLAGE_SECT = MASEC, TOUT_SECT = “OUI',
                                   COOR_AXE_POUTRE = (0. , 0. ,),),
                                   )

MOPOU=AFFE_MODELE (MAILLAGE=MAPOU,
           AFFE=_F (TOUT=' OUI', PHENOMENE=' MECANIQUE',
                  MODELISATION=' POU_D_EM',),);

BETON=DEFI_MATERIAU (
             ELAS=      _F (E=3.7272E10, NU=0.0, RHO=2400.0,),
             LABORD_1D= _F (Y01=310., Y02=0.070E+5, A1=9.E-3, A2=0.52E-5,
                    B1=1.2, B2=2., BETA1=0.1E+7, BETA2=-0.4E+8,
SIGF=3.5E+6))

ACIER=DEFI_MATERIAU (ELAS=_F (E=2.E11,  NU=0.0, RHO=7800.0,),
                    ECRO_LINE=_F (D_SIGM_EPSI=3.28E9, SY=4.E8,),);

MATOR=DEFI_MATERIAU (ELAS=_F (E=2.E11, NU=0.0, RHO=7800.0,));

POUCA=AFFE_CARA_ELEM (MODELE=MOPOU,
   POUTRE=_F (GROUP_MA=' POUTRE', SECTION=' RECTANGLE',
     CARA= (“HY”, “HZ”),
     VALE= (0.2, 0.5),
     PREC_AIRE=5., PREC_INERTIE=10.,
     ),
   ORIENTATION=_F (GROUP_MA=' POUTRE', CARA=' ANGL_VRIL', VALE=-90.0,),
   GEOM_FIBRE=GF,
   MULTIFIBRE=_F (GROUP_MA=' POUTRE', GROUP_FIBRE= (“SBET”, “SACI”)),
   );

COMPPMF=DEFI_COMPOR (GEOM_FIBRE=GF, MATER_SECT=MATOR,
    MULTIFIBRE= (
     _F (GROUP_FIBRE=' SACI', MATER=ACIER,
        RELATION=' VMIS_CINE_LINE'),
     _F (GROUP_FIBRE=' SBET', MATER=BETON,
         RELATION=' LABORD_1D'),
       ),
  )
```