

Notice for Orientation Relationship module Version 4.00 Academic Edition

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B. Beausir, J.-J. Fundenberger, Analysis Tools for Electron and X-ray diffraction, ATEX - software, www.atex-software.eu, Université de Lorraine - Metz, 2017

*M.* Humbert, F. Wagner, H. Moustahfid, C. Esling, Determination of the Orientation of a Parent β Grain from the Orientations of the Inherited α Plates in the Phase Transformation from Body-Centred Cubic to Hexagonal Close Packed. J. Appl. Cryst. (1995). 28, 571-576.

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## 1. Orientation Relationship Module

The module is located in the "Boundaries Advanced." Tab. Click on "O.R." button to open it.



The following window will appear,



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## 2. Set your Orientation relationship(s)

\land - Orientation Relationship

Orientation Relationship Definition								
Define the O.R. bellow or select from the predifined list and cick Add button (1)								
List:								
Genera' Parameters -								
Name: D Color. Tolerance Angle [°]; 5.00 🚖								
Planes and directions of Phase: 2 🛃 (3)								
Plane Indices: 1 🚔 1 🚔								
Direction Indices: 1 🗧 1 🖨 0 🖨								
parallel to planes and directions of Phase: 1 🗧 (4)								
Plane Indices: 0 🜩 0 🜩 o 1 🖨								
Direction Indices: 1 🗧 1 🖨 -2 0 🖨								
Hexagonal Convention: ⊙ x∥a ⊙ y∥a (5)								
Orientations								
メ 쿠 🗲 💼 🛨 🙆 👏								
✓ ID:{111}ph2//{0001}ph1 - <1-10>ph2//<11-20>ph1 Tol=5°								
Output Map Options								
Bgd coloring: Band Contrast 🔹 Thickness: 2 🖨								
Colorbar: 🗾 📕 Colorbar:								

You can set your orientation relationships either manually (3)(4) or from the predefined list (1)

(2) Set the name, the color and the disorientation tolerance angle for which the orientation relationship will be considered to be in orientation relationship or not.

(3,4) set the respective phases, the planes and directions of the O.R. According to your data, don't forget to choose the appropriate convention for phase with hexagonal symmetry. (5).

Click on the "Add" button to include the O.R. in the list

Click on "DO MAP" button to look for the O.R. in your map. (you can also set some options for the output map in the bellow panel)

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# **3.** Example with an $\gamma$ -based Titanium // Aluminides

## Phases



Step size: 0.2µm Resolution: 100x111 Index. Rate: 86% Magnification: x1000 Tension: 15kV

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The Orientation Relationship is

## (0001)hcp//(111)c and [11-20]hcp//[1-10]c

∧ - Orientation Relationship	-	×
Orientation Relationship Definition		
Define the O.R. bellow or select from the predifined list and click Add button		
Lite en		
Ceneral Parameters		
Name: D Color. Tolerance Angle ["]: 5.00 🚖		
Planes and directions of Phase 2 2		
parallel to planes and directions of Phase:		
Hexagonal Convention: O ×// a O y // a		
Orientations		
み 〒 チ 茴 十 ◎ ト 20		
Export Color Modify Remove Add Save Do Map		
☑ ID:(111)ph2//0001)ph1 - <1-10-ph2//<11-20-ph1 ToI-5°		
Output Map Options		
Bgd coloring: Phases • Thickness 4 • here (1) 33.42529		
Colorbar:		

93.4% of the boundaries between the two phases are in orientation relationship, with a disorientation less than 5°.

Note that if you add several O.R. in the list, if more than one OR display a disorientation less than the tolerance angle, the nearest (less disorientation) will be chosen and a map colored by the OR color will be plotted.

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Here is the corresponding map, boundaries in O.R. are colored with respect to the deviation of disorientation angle.



Disorientation [°] From Or. Relationship ID:{111}ph2//{0001}ph1 - <1-10>ph2//<11-20>ph1 ToI=5°

Step size: 0.2µm Resolution: 100x111 Index. Rate: 86% Magnification: x1000 Tension: 15kV Minimum: 0 Maximum: 5 Average: 9.5x10<sup>2</sup> S. Dev: 2.1x10<sup>2</sup> Entropy: 2.178 Median: 10x10<sup>2</sup> Mode: 10x10<sup>2</sup>

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You can plot the disorientation distribution of the O.R. in the "Statistic" Tab  $\rightarrow$  Distribution button

			O - Distributions									-	
			Selection	Nu	mber of c	:lasses: 32 হ	Options Min / Max: 0.03956	ş <u>5.0000</u> ş	Disorienta [*] From Relations 111]ph2//{	tion Or. hip 0001}	Phase 1	Integral	(%)
			On Grains     Number of Mainbhorn	Inte		ue: 1.00000 💠			5) 10>ph2//<1	1-20>		_	
			Grains Disorientations						0.0395646	80	0.1428733	2.3	21
^ - Orientation Maps Analysis : Ttz16SUB_01			Grains Disor. Uncorrelated						0.1945782	89	0.4920467	9.8	84
			On Plotted Maps     Euler Angles Map		1				0.3495918	81	0.8255912	22.	.64
My Data	F	Plots	Band Contrast						0.5046054	72	1.246201	41.	.96
Phases			Band Slope						0.6596190	92	1.368236	63.	
Local Info	<b>N</b>	- 14	<ul> <li>Disorientation [*] From Or. Relationship ID:[+++]ph2/[[ood</li> </ul>						0.8146327	13	0.7938127	/5/	47
Corrections	the second s								0.3636462	/5	0.5609436	64.	
- Correctiona			(1)						1.1240000	70	0.0440241	32.	00
Orientations	-		X*7						1.2756735	27	0.2163736	35.	.30
Boundaries		loois							1.5997009	10	0.04766792	90	50
Bound. Adv.	- <b>1</b>				i –	+			1 7447143	79	0.01321936	98	77
Intercepts	~	500							1 8997779	40	0.01588928	99	01
Grains									2 0547413	82	0.01588928	99	26
Grains Int				0.6					2 2097551	82	0.03177856	99	75
C N D	Cluster	s - K-means							2.3647687	43	0	99.	75
G.N.D.	K-means calculation	n are performed on the		04					2.5197823	04	0	99.	.75
Twins	calculations don't fo	rget to reselect the map							2.6747958	66	0	99.	.75
Cells - Traces									2.8298094	27	0	99.	.75
Miscellaneous		s to find: 📑 🔶				<b>t</b>			2.9848232	26	0	99.	.75
Simulations	On Pixel Values	s On Grain Values							3.1398367	88	0	99.	.75
Operators									3.2948503	49	0	99.	.75
Datterne	Results Options					- •		<u> </u>	3.4498639	10	0.01588928	10	00
Constanting of	Proces Maps bac		take the average < per grain >		ntation	[*] From Or. Relatio		ph1 - <1-10>ph2//<11-20>ph	Tol= 3.6048774	71	0	10	00
Statistics	Export ATEX file		🖸 Area Fraction 🔘 Number 😂) 🗹 All Phases						3.7598910	33	0	10	00
Results	Dates	d Chusters	This is a histogram, the integral is equal to 1, to get the						3.9149048	32	0	10	00
Textures	- Ovint		sum = 100% don't forget to multiply each values by the width of the classes (and by 100 !).			m histogram: Avera	ge = 0.758 - Standart Dev. =		4.0699181	55	0	10	00
Partitioning													

- (1) Make sure the O.R. map is selected
- (2) Select "All phases" to consider both phases in the distribution
- (3) Adapt the min and max of the distribution
- (4) If needed modify the number of classes
- (5) Click on the redraw button

The distribution should be the same than the one on the colorbar of the map



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You can also export the pixels in O.R. to plot their orientation by clicking on the "Export button", a new ebsd.atex file will be created in your working directory.



Click OK to open it, here is the exported phase map.



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You can now plot the orientation distribution function of the two phases in the "Textures" tab. Select the phase you want to plot the texture and click on "Pole Figures" Button.

### The two variants are well visible on (111) and (110) pole figures



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## 4. References

- [1] M. Humbert, F. Wagner, H. Moustahfid, C. Esling, Determination of the Orientation of a Parent β Grain from the Orientations of the Inherited α Plates in the Phase Transformation from Body-Centred Cubic to Hexagonal Close Packed. J. Appl. Cryst. (1995). 28, 571-576.
- [2] L. Germain, S.R. Dey, M. Humbert, N. Gey, Determination of parent orientation maps in advanced titanium-based alloys, Journal of Microscopy, Vol. 227, (2007), pp. 284–291.

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