SUPPLEMENTARY INFORMATION

Table 1 provides Euler angles of all β grains and TJ α for each of the 5 triple junctions that have been analyzed. Table 2-6 contains the deviation from BOR of all 36 possible TJ α variants at each triple junction from each of the 2 adjacent grains to which they are non-burgers oriented. The methods used in these calculations are similar to those used in [1] and are not repeated here. Finally, Table 8 provides all combinations of 3 β grains at a triple junction related by a special misorientations given in Table 7 [2] that will allow TJ α to be BOR related to all 3 grains

TJ 1	**Euler Angles** (Φ_1, Φ, Φ_2) [°]			**Disorientation** [°]
	Φ_1	Φ	Φ_2	Angle/ Axis
β_1	95.1	25.8	224.4	β_1/β_2 29.6°/ $[\overline{21}\ \bar{3}\ \bar{5}]$
β_2	24.2	25.0	296.7	β_2/β_3 46.5° $[4\ \overline{17}\ 11]$
β_3	195.6	30.7	203.8	β_3/β_1 46.0°/ $[\overline{26}\ \bar{3}\ \overline{10}]$
α	43.4	67.6	306.3	
TJ 2	**Euler Angles** (Φ_1, Φ, Φ_2) [°]			**Disorientation** [°]
	Φ_1	Φ	Φ_2	Angle/ Axis
β_1	286.9	26.9	33.8	β_1/β_2 19.4°/ $[13\ 8\ \overline{22}]$
β_2	262.1	25.9	72.1	β_2/β_3 32.5°/ $[2\ \bar{5}\ 23]$
β_3	266.6	18.6	126.2	β_3/β_1 19.9°/ $[\bar{2}\ 13\ \overline{19}]$
α	296.1	59.3	77.3	
TJ 3	**Euler Angles** (Φ_1, Φ, Φ_2) [°]			**Disorientation** [°]
	Φ_1	Φ	Φ_2	Angle/ Axis
β_1	169.2	35.7	195.9	β_1/β_2 51.3°/ $[18\ 16\ \overline{13}]$
β_2	56.3	27.5	342.6	β_2/β_3 49.1°/ $[11\ \overline{10}\ \bar{6}]$
β_3	155.0	33.4	181.5	β_3/β_1 27.4°/ $[3\ 7\ \overline{24}]$
α	109.7	58.3	265.2	
TJ 4	**Euler Angles** (Φ_1, Φ, Φ_2) [°]			**Disorientation** [°]
	Φ_1	Φ	Φ_2	Angle/ Axis
β_1	283.0	26.6	114.4	β_1/β_2 25.9°/ $[12\ \bar{4}\ 17]$
β_2	250.7	29.5	122.5	β_2/β_3 57.9°/$[16\ 5\ 16]$
β_3	68.2	36.6	326.8	β_3/β_1 59.8°/ $[13\ \overline{16}\ 9]$
α	169.9	83.0	192.1	
TJ 5	**Euler Angles** (Φ_1, Φ, Φ_2) [°]			**Disorientation** [°]
	Φ_1	Φ	Φ_2	Angle/ Axis
β_1	338.4	33.6	343.4	β_1/β_2 53.8°/ $[\overline{23}\ 3\ 17]$
β_2	68.3	36.7	326.7	β_2/β_3 49.3°/ $[23\ \overline{16}\ 2]$
$\Re_3$	313.3	43.1	7.6	β_3/β_1 18.6°/ $[5\ \bar{7}\ 2]$
α	264.9	53.0	74.8	

Table 1: The Euler angles (Bunge notation) for the three β grains constituting all TJ examined in this study. The disorientations between the 3 grains are also provided.

Variants are in BOR with β_1				
variant	ΔBOR_{th} with respect to β_2	variant	ΔBOR_{th} with respect to β_3	$\Delta BOR_{th\text{-}av}$
1	29.6°	1	23.7°	26.7°
2	22.4°	2	27.9°	25.1°
3	29.6°	3	33.9°	31.8°
4	25.0°	4	38.3°	31.6°
5	29.0°	5	34.8°	31.9°
6	21.5°	6	33.9°	27.7°
7	29.6°	7	43.1°	36.4°
8	25.7°	8	43.6°	34.7°
9	28.7°	9	20.2°	24.4°
10	29.6°	10	25.9°	27.7°
11	29.6°	11	32.1°	30.8°
12	29.6°	12	36.6°	33.1°
Variants are in BOR with β_2				
variant	ΔBOR_{th} with respect to β_1	variant	ΔBOR_{th} with respect to β_3	$\Delta BOR_{th\text{-}av}$
1	22.4°	1	22.1°	22.2°
2	29.6°	2	21.3°	25.5°
3	25.0°	3	32.2°	28.6°
4	29.6°	4	28.5°	29.1°
5	**21.5°**	**5**	**42.0°**	**31.8°**
6	29.0°	6	42.6°	35.8°
7	25.7°	7	28.5°	27.1°
8	29.6°	8	27.2°	28.4°
9	29.6°	9	27.2°	28.4°
10	28.7°	10	28.7°	28.7°
11	29.6°	11	13.4°	21.5°
12	29.6°	12	19.6°	24.6°
Variants are in BOR with β_3				
variant	ΔBOR_{th} with respect to β_1	variant	ΔBOR_{th} with respect to β_2	$\Delta BOR_{th\text{-}av}$
1	34.2°	1	19.6°	26.9°
2	32.1°	2	13.4°	22.7°
3	33.9°	3	21.3°	27.6°
4	34.8°	4	22.1°	28.4°
5	20.2°	5	35.8°	28.0°
6	25.9°	6	35.4°	30.6°
7	27.9°	7	27.2°	27.5°
8	23.7°	8	28.5°	26.1°
9	38.3	9	28.5°	33.4°
10	33.9°	10	32.2°	33.0°
11	38.0°	11	28.7°	33.4°
12	34.8°	12	27.2°	31.0°

Table 2: Analysis of TJ 1. The deviation from the BOR with adjacent grains for 3 three sets of 12 α variants that are oriented in the Burgers relationship with grains β_1, β_2 and β_2 respectively. The experimentally observed variant is in bold lettering.

Variants are in BOR with β_1				
variant	ΔBOR_{th} with respect to β_2	variant	ΔBOR_{th} with respect to β_3	$\Delta BOR_{th\text{-}av}$
1	16.2°	1	17.7°	16.9°
2	19.4°	2	19.9°	19.6°
3	19.4°	3	19.1°	19.2°
4	19.4°	4	19.9°	19.6°
5	19.4°	5	9.8°	14.6°
6	19.4°	6	19.9°	19.6°
7	10.5°	7	19.9°	15.2°
8	19.4°	8	19.9°	19.6°
9	18.3°	9	19.9°	19.1°
10	19.4°	10	15.4°	17.4°
11	12.8°	11	19.9°	16.3°
12	19.4°	12	17°	18.2°
Variants are in BOR with β_2				
variant	ΔBOR_{th} with respect to β_1	variant	ΔBOR_{th} with respect to β_3	$\Delta BOR_{th\text{-}av}$
1	19.4°	1	32.6°	26°
2	16.2°	2	32.6°	24.4°
3	19.4°	3	31.9°	25.7°
4	19.4°	4	32.6°	26°
5	19.4°	5	25.6°	22.5°
6	19.4°	6	32.6°	26°
7	19.4°	7	32.6°	26°
8	10.5°	8	27.2°	18.8°
9	19.4°	9	32.6°	26°
10	18.3°	10	28.3°	23.3°
11	19.4°	11	28°	23.7°
12	12.8°	12	24.4°	18.6°
Variants are in BOR with β_3				
variant	ΔBOR_{th} with respect to β_1	variant	ΔBOR_{th} with respect to β_2	$\Delta BOR_{th\text{-}av}$
1	19.1°	1	31.9°	25.5°
2	19.9°	2	32.6°	26.2°
3	19.9°	3	32.6°	26.2°
4	17.7°	4	32.6°	25.1°
5	19.9°	5	32.6°	26.2°
6	15.4°	6	28.3°	21.8°
7	**17°**	**7**	**24.4°**	**20.7°**
8	19.9°	8	28°	24°
9	19.9°	9	27.2°	23.5°
10	19.9°	10	32.6°	26.2°
11	9.8°	11	25.6°	17.7°
12	19.9°	12	32.6°	26.2°

Table 3: Analysis of TJ 2. The deviation from the BOR with adjacent grains for 3 three sets of 12 α variants that are oriented in the Burgers relationship with grains β_1, β_2 and β_2 respectively. The experimentally observed variant is in bold lettering.

Variants are in BOR with β_1				
variant	ΔBOR_{th} with respect to β_2	variant	ΔBOR_{th} with respect to β_3	$\Delta BOR_{th\text{-}av}$
1	27.8°	1	27.4°	27.6°
2	24.2°	2	26.3°	25.3°
3	11.1°	3	27.4°	19.2°
4	14.7°	4	27.4°	21.0°
5	11.3°	5	22.9°	17.1°
6	11.1°	6	27.4°	19.2°
7	33.3°	7	27.4°	30.3°
8	31.0°	8	20.5°	25.7°
9	18.9°	9	27.4°	23.1°
10	11.1°	10	24.2°	17.6°
11	38.8°	11	27.4°	33.1°
12	34.6°	12	18.9°	26.7°
Variants are in BOR with β_2				
variant	ΔBOR_{th} with respect to β_1	variant	ΔBOR_{th} with respect to β_3	$\Delta BOR_{th\text{-}av}$
1	18.9°	1	15.1°	17.0°
2	11.1°	2	15.1°	13.1°
3	31.0°	3	22.7°	26.8°
4	34.9°	4	18.2°	26.6°
5	**11.1°**	**5**	**16.6°**	**13.8°**
6	11.3°	6	24.9°	18.1°
7	24.2°	7	38.7°	31.5°
8	27.8°	8	33.9°	30.9°
9	33.3°	9	31.0°	32.1°
10	33.3°	10	30.3°	31.8°
11	11.1°	11	16.6°	13.8°
12	14.7°	12	17.7°	16.2°
Variants are in BOR with β_3				
variant	ΔBOR_{th} with respect to β_1	variant	ΔBOR_{th} with respect to β_2	$\Delta BOR_{th\text{-}av}$
1	26.3°	1	18.2°	22.2°
2	27.4°	2	22.7°	25.0°
3	27.4°	3	16.6°	22.0°
4	27.4°	4	17.7°	22.5°
5	27.4°	5	24.9°	26.2°
6	22.9°	6	16.6°	19.8°
7	20.5°	7	37.1°	28.8°
8	27.4°	8	42.0°	34.7°
9	24.2°	9	15.1°	19.6°
10	27.4°	10	15.1°	21.2°
11	18.9°	11	30.3°	24.6°
12	27.4°	12	31.0°	29.2°

Table 4: Analysis of TJ 3. The deviation from the BOR with adjacent grains for 3 three sets of 12 α variants that are oriented in the Burgers relationship with grains β_1, β_2 and β_3 respectively. The experimentally observed variant is in bold lettering.

Variants are in BOR with β_1				
variant	ΔBOR_{th} with respect to β_2	variant	ΔBOR_{th} with respect to β_3	ΔBOR_{av}
1	25.1°	1	7.2	16.2
2	25.9°	2	7.2	16.5
3	22.1°	3	25.2	23.7
4	25.9°	4	25.2	25.6
5	15.9°	5	12.7	14.3
6	25.2°	6	22.6	23.9
7	25.9°	7	38.2	32.0
8	25.9°	8	37.2	31.6
9	25.9°	9	24.2	25.1
10	23.3°	10	24.2	23.8
11	25.9°	11	12.7	19.3
12	20.0°	12	15.9	17.9
Variants are in BOR with β_2				
variant	ΔBOR_{th} with respect to β_1 (in degrees)	variant	ΔBOR_{th} with respect to β_3	ΔBOR_{tav}
1	25.9°	1	19.2°	22.5°
2	25.1°	2	18.2°	21.7°
3	25.9°	3	19.5°	22.7°
4	22.1°	4	19.5°	20.8°
5	25.2°	5	12.4°	18.8°
6	15.9°	6	12.4°	14.1°
7	25.9°	7	19.8°	22.8°
8	25.9°	8	19.8°	22.8°
9	23.3°	9	42.2°	32.7°
10	25.9°	10	40.7°	33.3°
11	20.0°	11	18.2°	19.1°
12	25.9°	12	22.5°	24.2°°
Variants are in BOR with β_3				
variant	ΔBOR_{th} with respect to β_1	variant	ΔBOR_{th} with respect to β_2	$\Delta BOR_{th\text{-}av}$
1	7.2°	1	18.2°	12.7°
2	**7.2°**	**2**	**19.2°**	**13.2°**
3	24.2°	3	19.8°	22.0°
4	24.2°	4	19.8°	22.0°
5	25.2°	5	42.1°	33.7°°
6	25.2°	6	40.5°	32.9°
7	15.9°	7	22.5°	19.2°
8	12.7°	8	18.2°	15.4°
9	12.7°	9	12.4°	12.5°
10	22.6°	10	12.4°	17.5°
11	35.8°	11	19.5°	27.7°
12	37.5°	12	19.5°	28.5°

Table 5: Analysis of TJ 4. The deviation from the BOR with adjacent grains for 3 three sets of 12 α variants that are oriented in the Burgers relationship with grains β_1, β_2 and β_3 respectively. The experimentally observed variant is in bold lettering.

Variants are in BOR with β_1				
variant	ΔBOR_{th} with respect to β_2	variant	ΔBOR_{th} with respect to β_3	$\Delta BOR_{th\text{-}av}$
1	19.7°	1	18.6	19.1
2	27.9°	2	18.6	23.2
3	34.3°	3	18.6	26.5
4	31.6°	4	9.0	20.3
5	23.7°	5	18.6	21.2
6	22.0°	6	15.4	18.7
7	9.9°	7	18.6	14.2
8	11.5°	8	18.6	15.0
9	19.7°	9	18.6	19.1
10	24.2°	10	17.3	20.7
11	28.9°	11	13.2	21.1
12	28.9°	12	18.6	23.8
Variants are in BOR with β_2				
variant	ΔBOR_{th} with respect to β_1	variant	ΔBOR_{th} with respect to β_3	$\Delta BOR_{th\text{-}av}$
1	28.9°	1	30.6°	29.7°
2	28.9°	2	31.1°	30.0°
3	11.5°	3	14.6°	13.0°
4	**9.9°**	**4**	**9.0°**	**9.4°**
5	27.9	5	29.0°	28.4
6	19.7°	6	23.8°	21.7°
7	38.2°	7	24.3°	31.2°
8	38.2°	8	25.9°	32.0°
9	24.2°	9	31.1°	27.6°
10	19.7°	10	23.8°	21.7°
11	23.7°	11	37.2°	30.5°
12	22.0°	12	37.2°	29.6°
Variants are in BOR with β_3				
variant	ΔBOR_{th} with respect to β_1	variant	ΔBOR_{th} with respect to β_2	$\Delta BOR_{th\text{-}av}$
1	18.6°	1	23.8°	21.2°
2	18.6°	2	29.0°	23.8°
3	9.0°	3	31.1°	20.0°
4	18.6°	4	31.1°	24.9°
5	15.4°	5	24.3°	19.8°
6	18.6°	6	25.9°	22.2°
7	18.6°	7	9.0°	13.8°
8	18.6°	8	14.6°	16.6°
9	17.3°	9	23.8°	20.5°
10	18.6°	10	31.1°	24.9°
11	18.6°	11	32.9°	25.7°
12	13.2°	12	30.6°	21.9°

Table 6: Analysis of TJ 5. The deviation from the BOR with adjacent grains for 3 three sets of 12 α variants that are oriented in the Burgers relationship with grains β_1, β_2 and β_3 respectively. The experimentally observed variant is in bold lettering.

The 4 special misorientations between β grains that allow GB α to be BOR related to both pairs of grains are given in Table 7 [2]

.

1.	$[011]/60^0$
2.	$[011]/49.47^0$
3.	$[011]/10.52^0$
4.	$[111]/60^0$

Table 7: Special misorientations between β grains [2]

A brute force method has been used to examine the misorientations between 3 β grains at a triple junction that will allow an α variant at the triple junction to be Burgers related to all 3 grains. The method consists of selecting a given [110] axis in grain 1 and establishing the orientation of grain 2 when rotated by a Type 1 misorientation as in Table 7 above. Then the orientation of grain 3 is established from grain 2 by rotation about all possible <110> and <111> axes of grain 2 (including positive and negative rotations) by the angles associated with Type 1-4 misorientations of Table 7. Finally, the disorientation between grain 1 and grain 3 is then examined for all these possibilities. The combinations that lead to special orientations between grain 1 and grain 3 as well are highlighted in bold in Table 8. These again reduce to 4 distinct cases of special misorientations at triple junctions that will allow TJ α to be BOR related to all 3 grains of triple junction.

Sl. No	$\boldsymbol{\beta_{12}}$ ***axis***	$\boldsymbol{\beta_{12}}$ (°)	$\boldsymbol{\beta_{23}}$ ***axis***	$\boldsymbol{\beta_{23}}$ (°)	$\boldsymbol{\beta_{13}}$ ***axis***	$\boldsymbol{\beta_{13}}$ (°)
1	**[110]**	**60**	**[-1-10]**	**60**	**[1 1 0]**	**60**
2	[110]	60	[1-10]	60	[-0.7 0.4 0.7]	31.1
3	[110]	60	[-110]	60	[0.4-0.7-0.7]	31.1
4	[110]	60	[101]	60	[0.1-0.6-0.8]	45.1
5	[110]	60	[-10-1]	60	[0.4 0.8 0.4]	18.2
6	[110]	60	[10-1]	60	[0.6 0.8-0.1]	45.1
7	[110]	60	[-101]	60	[-0.3-0.0 1.0]	31.1
8	[110]	60	[011]	60	[0.8 0.6 0.1]	45.1
9	[110]	60	[0-1-1]	60	[-0.0-0.3-1.0]	31.1
10	[110]	60	[01-1]	60	[-0.6 0.1 0.8]	45.1
11	[110]	60	[0-11]	60	[0.8 0.4-0.4]	18.2
12	**[110]**	**-60**	**[110]**	**60**	**[-1-10]**	**60**
1	**[110]**	**60**	**[110]**	**49.5**	**[-1-10]**	**10.5**
2	**[110]**	**60**	**[-1-10]**	**49.5**	**[-111]**	**60**
3	[110]	60	[1-10]	49.5	[-0.7 0.6 0.4]	30.6
4	[110]	60	[-110]	49.5	[0.6-0.7-0.4]	30.6
5	[110]	60	[101]	49.5	[-0.4-0.5 0.8]	54
6	[110]	60	[-10-1]	49.5	[0.3 0.8 0.6]	27.8
7	[110]	60	[10-1]	49.5	[0.4 0.9-0.2]	42.8
8	[110]	60	[-101]	49.5	[-0.0-0.2 1.0]	30.6
9	[110]	60	[011]	49.5	[0.9 0.4 0.2]	42.8
10	[110]	60	[0-1-1]	49.5	[-0.2-0.0-1.0]	30.6
11	[110]	60	[01-1]	49.5	[-0.5-0.4-0.8]	54
12	[110]	60	[0-11]	49.5	[0.8 0.3-0.6]	27.8
1	**[110]**	**60**	**[110]**	**10.5**	**[-1-10]**	**49.5**
2	**[110]**	**60**	**[-1-10]**	**10.5**	**[-11-1]**	**60**
3	[110]	60	[1-10]	10.5	[-0.6 0.7-0.4]	52.1
4	[110]	60	[-110]	10.5	[0.7-0.6 0.4]	52.1

5	[110]	60	[101]	10.5	[-0.7-0.7 0.2]	55.4
6	[110]	60	[-10-1]	10.5	[0.6-0.6 0.4]	60
7	[110]	60	[10-1]	10.5	[-0.4 0.8-0.5]	54
8	[110]	60	[-101]	10.5	[0.7-0.5 0.6]	52.1
9	[110]	60	[011]	10.5	[0.8-0.4 0.5]	54
10	[110]	60	[0-1-1]	10.5	[-0.5 0.7-0.6]	52.1
11	[110]	60	[01-1]	10.5	[-0.7-0.7-0.2]	55.4
12	[110]	60	[0-11]	10.5	[-0.6 0.6-0.4]	60
1	[110]	60	[111]	60	[-0.5 0.2 0.8]	34.8
2	[110]	60	[-1-1-1]	60	[-0.5 0.2 0.8]	34.8
3	[110]	60	[11-1]	60	[0.2-0.5-0.8]	34.8
4	[110]	60	[-1-11]	60	[0.2-0.5-0.8]	34.8
5	**[110]**	**60**	**[-111]**	**60**	**[110]**	**10.5**
6	**[110]**	**60**	**[1-1-1]**	**60**	**[110]**	**10.5**
7	**[110]**	**60**	**[1-11]**	**60**	**[110]**	**49.5**
8	**[110]**	**60**	**[-11-1]**	**60**	**[110]**	**49.5**

Table 8: The table lists all possible combinations of special misorientation relationships (see Table 1 of the main paper) between adjacent grains β_1/β_2 and β_2/β_3 at a triple junction. Those in bold lettering also allow a special misorientation relationship between β_2/β_3

[1] R. Shi, V. Dixit, G.B. Viswanathan, H.L. Fraser and Y. Wang, *Experimental assessment of variant selection rules for grain boundary α in titanium alloys*, Acta Mater. 102 (2016), pp. 197–211.

[2] C. Cayron, *Importance of the α→β transformation in the variant selection mechanisms of thermomechanically processed titanium alloys*, Scr. Mater. 59 (2008), pp. 570–573.