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# GENERALISED ESTIMATION OF CRITICAL CURRENT DENSITY AND TEXTURE FACTOR OF IRON BASED SUPERCONDUCTOR FeSe0.5Te0.5, Sr0.8K0.2Fe2As2 AT 5K AND 0.1T BY AN EXPANSION INTO DIRECTION COSINES $\alpha_1,\alpha_2,\alpha_3$ WITH RESPECT TO THE CRYSTAL AXES

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**Abstract**
In this present article, Critical Current Density$J_c$, Texture Factor A of Iron Based Superconductor FeSe0.5Te0.5 is expressed by an expansion into Direction Cosines $\alpha_1$, α2, α3 with respect to the crystal axes. The General Equation of Critical Current Density, Texture Factor of Iron Based Superconductor FeSe0.5Te0.5 can be used to determine their values at <100>, <110>, <111> directions respectively. In the present article Critical Current Density, Texture Factor of Iron Based Superconductor FeSe0.5Te0.5 is determined at <100>, <110>, <111> directions respectively. The Equation can be generalized to include any Super Conductor with anisotropic property.

**Keywords:**
anisotropic. Critical Current Density, Texture Factor, SuperConductor, Direction Cosines

## I. Introduction

Anisotropic Properties are those properties which vary with crystal direction Critical Current Density$J_c$, of Iron Based Superconductor FeSe0.5Te0.5 is different at <100>,<110>,<111> directions viz. 8.6,1.9,27 (*$10^4$ ) A/$cm^2$respectively. Texture Factor of Iron Based Superconductor FeSe0.5Te0.5 is different at <100>,<110>,<111> directions viz. 4.1975,1.534,9 . Critical Current Density, Texture Factor of Iron Based Superconductor FeSe0.5Te0.5 can be expressed as an expansion into direction cosines $\alpha_1,\alpha_2,\alpha_3$ with respect to the crystal axes.In the present article, consideration is made up to seven terms.

### 1.1 Standard Equation:

$$J_c^* = K_0 + K_1 (\sum\alpha^2_1 \alpha^2_2) + K_2 (\prod\alpha^2_1) + K_3 (\sum\alpha^2_1 \alpha^2_2)^2 + K_4 (\sum\alpha^2_1 \alpha^2_2)(\prod\alpha^2_1) + K_5 (\sum\alpha^2_1 \alpha^2_2)^3 + K_6 (\prod\alpha^2_1)^2$$

$$A^* = K_0 + K_1 (\sum\alpha^2_1 \alpha^2_2) + K_2 (\prod\alpha^2_1) ) + K_3 (\sum\alpha^2_1 \alpha^2_2)^2 + K_4 (\sum\alpha^2_1 \alpha^2_2)(\prod\alpha^2_1) + K_5 (\sum\alpha^2_1 \alpha^2_2)^3 + K_6 (\prod\alpha^2_1)^2$$

| [uvw] | a | b | c | $\alpha_1$ | $\alpha_2$ | $\alpha_3$ | $J_c$, & A |
|---|---|---|---|---|---|---|---|
| <100> | 0 | $90^0$ | $90^0$ | 1 | 0 | 0 | $K_0$ |
| <110> | $45^0$ | $45^0$ | $90^0$ | 1/√2 | 1/√2 | 0 | $K_0 + K_1/4$ |
| <111> | $54.7^0$ | $54.7^0$ | $54.7^0$ | 1/√3 | 1/√3 | 1/√3 | $K_0 + K_1/3 + K_2/27$ |

## II. Calculation Critical Current Density$J_c$, of Iron Based Superconductor FeSe0.5Te0.5 Of An Expansion Into Direction Cosines $\alpha_1,\alpha_2,\alpha_3$ With Respect To The Crystal Axes

$$J_c^* = K_0 + K_1 (\sum\alpha^2_1 \alpha^2_2) + K_2 (\prod\alpha^2_1) ) + K_3 (\sum\alpha^2_1 \alpha^2_2)^2 + K_4 (\sum\alpha^2_1 \alpha^2_2)(\prod\alpha^2_1) + K_5 (\sum\alpha^2_1 \alpha^2_2)^3 + K_6 (\prod\alpha^2_1)^2$$

For <100> directions, $\alpha_1$ =1, α2 =0, $\alpha_3$=0 ….[ I ]
For <110> directions, $\alpha_1$ =1/√2, α2 =1/√2, $\alpha_3$=0….[ II]
For <111> directions, $\alpha_1$ =1/√3, α2 =1/√3, $\alpha_3$=1/√3….[ III ]

### 2.1 Calculation Of Critical Current Density$J_c$, of Iron Based Superconductor FeSe0.5Te0.5

| S.No | Crystallographic Directions | Critical Current Density,Jc ( *$10^4$) |
|---|---|---|
| **1.** | **<100>** | **8.6 A/$cm^2$** |
| **2.** | **<110>** | **1.9 A/$cm^2$** |
| **3.** | **<111>** | **27 A/$cm^2$** |

For <100> directions, $\alpha_1 =1, \alpha 2 =1, \alpha_3=0$ ….[ I ], in Standard Equation

$$J_c^* = K_0 + K_1 (\sum\alpha^2_1\ \alpha^2_2) + K_2 (\prod\alpha^2_1) ) + K_3 (\sum\alpha^2_1\ \alpha^2_2)^2 + K_4 (\sum\alpha^2_1\ \alpha^2_2)(\prod\alpha^2_1) + K_5 (\sum\alpha^2_1\ \alpha^2_2)^3 + K_6 (\prod\alpha^2_1)^2$$

We have

$$J^*_{[100]} = K_0 = 8.6;$$

For <110> directions, $\alpha_1 =1/\sqrt{2}, \alpha 2 =1/\sqrt{2}, \alpha_3=0$

Using [ II ] , in Standard Equation

$$1.9= K_0 + K_1 (\sum\alpha^2_1\ \alpha^2_2) + K_2 (\prod\alpha^2_1) + K_3 (\sum\alpha^2_1\ \alpha^2_2)^2 + K_4 (\sum\alpha^2_1\ \alpha^2_2)(\prod\alpha^2_1) + K_5 (\sum\alpha^2_1\ \alpha^2_2)^3 + K_6 (\prod\alpha^2_1)^2$$

⇨ $1.9 = 8.6+ K_1/4 + K_3/16 + K_5/64$

⇨ $[16K_1+ 4K_3 + K_5] = -428.8$ ……..[ IV ];

For <111> directions, $\alpha_1 =1/\sqrt{3}, \alpha 2 =1/\sqrt{3}, \alpha_3=1/\sqrt{3}$….[ III ];

Using [ III] , in Standard Equation

$$J^* = K_0 + K_1 (\sum\alpha^2_1\ \alpha^2_2) + K_2 (\prod\alpha^2_1) + K_3 (\sum\alpha^2_1\ \alpha^2_2)^2 + K_4 (\sum\alpha^2_1\ \alpha^2_2)(\prod\alpha^2_1) + K_5 (\sum\alpha^2_1\ \alpha^2_2)^3 + K_6 (\prod\alpha^2_1)^2$$

$27 = 8.6 + K_1/3 + K_2/27+ K_3/9+ K_4/81+ K_5 /27+ K_6 /729 = 125 + K_1/3 + K_5/27+ K_3/9+ K_4/81+ K_2 /27+ K_6 /729$ **[re-arraging $K_2$, $K_5$**

⇨ $27[9K_1+ 3K_3 + K_5] +9[K_4+ 3K_2 + K_6]= 18.4 * 729 = 13413.6$

⇨ $27 * 495 +9 * 5.4 = 13413.6$

⇨ $[9K_1+ 3K_3 + K_5] =495$….[ V];

⇨ $[K_4+ 3K_2 + K_6]= 5.4$

⇨ $1+3*1+1.4= 5.4$

⇨ $K_4 = 1; K_2=1; K_6=1.4$

⇨ **From[ IV ] - [ V];We have**

⇨ $16K_1+ 4K_3 + K_5= -428.8$

**(-)**

$9K_1+ 3K_3 + K_5 = 495$

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$7K_1+ K_3 = -923.8$

⇨ $7* -131 -6.8 = -923.8;$

⇨ $K_1= -131;K_3 = -6.8;$

⇨ $K_5 =495 + 3*6.8 +9*131$

⇨ $K_5 =1694.4$

**Substituting ,** $K_0, K_1, K_2\ K_3, K_4, K_5, K_6$ ,in standard equation, we have $Y^* = K_0 + K_1 (\sum\alpha^2_1\ \alpha^2_2) + K_2 (\prod\alpha^2_1) + K_3 (\sum\alpha^2_1\ \alpha^2_2)^2 + K_4 (\sum\alpha^2_1\ \alpha^2_2)(\prod\alpha^2_1) + K_5 (\sum\alpha^2_1\ \alpha^2_2)^3 + K_6 (\prod\alpha^2_1)^2$

$K_0=8.6$, $K_1= -131$, $K_2=1$; $K3= -6.8$; $K_4= 1$; $K_5=1694.4$; $K_6 =1.4$

$$J^*_{FeSe0.5Te0.5} = 8.6 -131 (\sum\alpha^2_1\ \alpha^2_2) +1 (\prod\alpha^2_1) -6.8(\sum\alpha^2_1\ \alpha^2_2)^2 +1 (\sum\alpha^2_1\ \alpha^2_2)(\prod\alpha^2_1) + 1694.4 (\sum\alpha^2_1\ \alpha^2_2)^3 + 1.4(\prod\alpha^2_1)^2$$ ……….[ VI ];

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⇨ **[ VI ] ABOVE IS GENERALISED ESTIMATION CRITICAL CURRENT DENSITY $J_c$ OF IRON BASED SUPERCONDUCTOR FeSe0.5Te0.5**
⇨ **BY AN EXPANSION INTO DIRECTION COSINES $\alpha_1,\alpha_2,\alpha_3$ WITH RESPECT TO THE CRYSTAL AXES**

⇨ **FOR <100> Directions, $J^*_{FeSe0.5Te0.5}$ = 8.6**

⇨ **FOR <110> Directions, $J^*_{FeSe0.5Te0.5}$= 8.6 -131/4 -6.8 /16 +1694.4/64 = 1.9**

⇨ **FOR <111> Directions, $J^*_{FeSe0.5Te0.5}$=8.6 -131/3 + 1/27 -6.8/9 + 1/81 + 1694.4/27 + 1.4/729 = 26.9846364883 approx = 27**

⇨ **ABOVE VALUES,CONFORM TO THE STANDARD CRITICAL CURRENT DENSITY $J_c$ OF IRON BASED SUPERCONDUCTOR FeSe0.5Te0.5**

**IV. Calculation Texture Factor, of Iron Based Superconductor FeSe0.5Te0.5 Of An Expansion Into Direction Cosines $\alpha_1,\alpha_2,\alpha_3$ With Respect To The Crystal Axes**

$$A^* = K_0 + K_1 (\sum\alpha^2_1 \alpha^2_2) + K_2 (\prod\alpha^2_1) )+ K_3 (\sum\alpha^2_1 \alpha^2_2)^2 + K_4 (\sum\alpha^2_1 \alpha^2_2)(\prod\alpha^2_1) + K_5 (\sum\alpha^2_1 \alpha^2_2)^3+ K_6 (\prod\alpha^2_1)^2$$

**From literature we have, Relation Between Texture Factor and Critical Current Density,$J_c$ = $A^{1.5}$ => A = $J_c^{0.667}$ (Approx)**

| S.No | Crystallographic Directions | Critical Current Density,Jc ( $*10^4$) | Texture Factor( *465.586093523) | Magnetic Anisotropy Energy Density of iron E*=0.355A*-1.898 |
|---|---|---|---|---|
| 1. | <100> | 8.6 A/cm$^2$ | 4.200 | -0.407 |
| 2. | <110> | 1.9 A/cm$^2$ | 1.534 | -1.3543 |
| 3. | <111> | 27 A/cm$^2$ | 9.009 | 1.300195 |

**DISCUSSION:**

The <110>//ND fibre accounts for the lowest anisotropy energy since the flux lines, distributed homogenously in a plane of the rotating laminated sheet, have an easiest magnetization direction with the in-plane rotated cube texture components. On the contrary, the <100>//ND,<111>//RD fibre orientations have relatively high anisotropy energy and as such, the occurrence of these components in pure iron is undesirable.

**$A^*_{[100]} = K_0$ = 4.2;**
For <110> directions, $\alpha_1 = 1/\sqrt{2}$, $\alpha 2 = 1/\sqrt{2}$, $\alpha_3 = 0$
Using [ II ] , in Standard Equation

$$1.534= K_0 + K_1 (\sum\alpha^2_1 \alpha^2_2) + K_2 (\prod\alpha^2_1) + K_3 (\sum\alpha^2_1 \alpha^2_2)^2 + K_4 (\sum\alpha^2_1 \alpha^2_2)(\prod\alpha^2_1) + K_5 (\sum\alpha^2_1 \alpha^2_2)^3+ K_6 (\prod\alpha^2_1)^2$$

⇨ **1.534= 4.2+ $K_1/4 + K_3/16 + K_5/64$**
⇨ **[$16K_1 + 4K_3 + K_5$] = -170.624……..[ IV ];**

For <111> directions, $\alpha_1 = 1/\sqrt{3}$, $\alpha 2 = 1/\sqrt{3}$, $\alpha_3 = 1/\sqrt{3}$….[ III ];
Using [ III] , in Standard Equation

$$J^* = K_0 + K_1 (\sum\alpha^2_1 \alpha^2_2) + K_2 (\prod\alpha^2_1) + K_3 (\sum\alpha^2_1 \alpha^2_2)^2 + K_4 (\sum\alpha^2_1 \alpha^2_2)(\prod\alpha^2_1) + K_5 (\sum\alpha^2_1 \alpha^2_2)^3+ K_6 (\prod\alpha^2_1)^2$$

**9.009 = 4.2+ $K_1/3 + K_2/27+ K_3/9+ K_4/81+ K_5 /27+ K_6 /729$ = 125 + $K_1/3 + K_5/27+ K_3/9+ K_4/81+ K_2 /27+ K_6 /729$ [re-arraging $K_2$, $K_5$**

⇨ **27[$9K_1+ 3K_3 + K_5$] +9[$K_4+ 3K_2 + K_6$]= 4.809* 729 = 3505.761**

**⇨ 27 * 129+9 * 2.529 = 3505.761**
**⇨ [$9K_1 + 3K_3 + K_5$] =129….[ V];**
**⇨ [$K_4 + 3K_2 + K_6$]= 2.529**
**⇨ -1+3*1+0.529= 2.529**
**⇨ $K_4 = -1$; $K_2=1$; $K_6=0.529$**

**⇨ From[ IV ] - [ V];We have**

**⇨ $16K_1 + 4K_3 + K_5 = -170.624$**

**(-)**

**$9K_1 + 3K_3 + K_5 = 129$**

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**$7K_1 + K_3 = -299.624$**
**⇨ 7* (-42) -5.624= -923.8;**
**⇨ $K_1= -42$;$K_3 = -5.624$;**
**⇨ $K_5$ =129+3*5.624+9*42**
**⇨ $K_5$ =523.872**

**Substituting , $K_0$, $K_1$, $K_2$ $K_3$, $K_4$, $K_5$, $K_6$** ,in standard equation, we have **$Y^* = K_0 + K_1 (\sum\alpha^2_1 \alpha^2_2) + K_2 (\prod\alpha^2_1) + K_3 (\sum\alpha^2_1 \alpha^2_2)^2 + K_4 (\sum\alpha^2_1 \alpha^2_2)(\prod\alpha^2_1) + K_5 (\sum\alpha^2_1 \alpha^2_2)^3 + K_6 (\prod\alpha^2_1)^2$**
**$K_0$=4.2, $K_1$= -42, $K_2$=1; K3= -5.624; $K_4$= -1; $K_5$=523.872; $K_6$ =0.529**

**$A^*_{FeSe0.5Te0.5} = 4.2 -42 (\sum\alpha^2_1 \alpha^2_2) +1 (\prod\alpha^2_1) -5.624(\sum\alpha^2_1 \alpha^2_2)^2 -1 (\sum\alpha^2_1 \alpha^2_2)(\prod\alpha^2_1) + 523.872(\sum\alpha^2_1 \alpha^2_2)^3 + 0.529(\prod\alpha^2_1)^2$ ……….[ VI ];**
**⇨ FOR <100> Directions, $A^*_{FeSe0.5Te0.5}$ = 4.2**

**⇨ FOR <110> Directions, $A^*_{FeSe0.5Te0.5}$= 4.2 -42/4 -5.624 /16 +523.872/64 = 1.534**

**⇨ FOR <111> Directions, $A^*_{FeSe0.5Te0.5}$=4.2 -42/3 + 1/27 -5.624/9 -1/81 + 523.872/27 + 0.529/729 = 9.00319478738 approx = 9.009**
**Calculation Critical Current Density$J_c$, of Iron Based Superconductor Sr0.8K0.2Fe2As2 Of An Expansion Into Direction Cosines $\alpha_1$,$\alpha_2$,$\alpha_3$ With Respect To The Crystal Axes**

**$J_c^* = K_0 + K_1 (\sum\alpha^2_1 \alpha^2_2) + K_2 (\prod\alpha^2_1) ) + K_3 (\sum\alpha^2_1 \alpha^2_2)^2 + K_4 (\sum\alpha^2_1 \alpha^2_2)(\prod\alpha^2_1) + K_5 (\sum\alpha^2_1 \alpha^2_2)^3 + K_6 (\prod\alpha^2_1)^2$**
For <100> directions, $\alpha_1$ =1, $\alpha 2$ =0, $\alpha_3$=0 ….[ I ]
For <110> directions, $\alpha_1 =1/\sqrt{2}$, $\alpha 2 =1/\sqrt{2}$, $\alpha_3$=0….[ II]
For <111> directions, $\alpha_1 =1/\sqrt{3}$, $\alpha 2 =1/\sqrt{3}$, $\alpha_3=1/\sqrt{3}$….[ III ]

**2.1 Calculation Of Critical Current Density$J_c$, of Iron Based Superconductor Sr0.8K0.2Fe2As2**

| S.No | Crystallographic Directions | Critical Current Density,Jc ( *$10^4$) |
|---|---|---|
| 1. | <100> | 2 A/$cm^2$ |
| 2. | <110> | 3 A/$cm^2$ |
| 3. | <111> | 4.5 A/$cm^2$ |

For <100> directions, $\alpha_1$ =1, $\alpha 2$ =1, $\alpha_3$=0 ….[ I ], in Standard Equation
**$J_c^* = K_0 + K_1 (\sum\alpha^2_1 \alpha^2_2) + K_2 (\prod\alpha^2_1) ) + K_3 (\sum\alpha^2_1 \alpha^2_2)^2 + K_4 (\sum\alpha^2_1 \alpha^2_2)(\prod\alpha^2_1) + K_5 (\sum\alpha^2_1 \alpha^2_2)^3 + K_6 (\prod\alpha^2_1)^2$**
We have

**$J^*_{[100]} = K_0 = 2$;**

For <110> directions, $\alpha_1 = 1/\sqrt{2}$, $\alpha 2 = 1/\sqrt{2}$, $\alpha_3 = 0$

Using [ II ] , in Standard Equation

**$3 = K_0 + K_1 (\sum\alpha^2{}_1\ \alpha^2{}_2) + K_2 (\prod\alpha^2{}_1) + K_3 (\sum\alpha^2{}_1\ \alpha^2{}_2)^2 + K_4 (\sum\alpha^2{}_1\ \alpha^2{}_2)(\prod\alpha^2{}_1) + K_5 (\sum\alpha^2{}_1\ \alpha^2{}_2)^3 + K_6 (\prod\alpha^2{}_1)^2$**

⇨ **$3 = 2 + K_1/4 + K_3/16 + K_5/64$**

⇨ **$[16K_1 + 4K_3 + K_5] = 64$ ……..[ IV ];**

For <111> directions, $\alpha_1 = 1/\sqrt{3}$, $\alpha 2 = 1/\sqrt{3}$, $\alpha_3 = 1/\sqrt{3}$….[ III ];

Using [ III] , in Standard Equation

**$J^* = K_0 + K_1 (\sum\alpha^2{}_1\ \alpha^2{}_2) + K_2 (\prod\alpha^2{}_1) + K_3 (\sum\alpha^2{}_1\ \alpha^2{}_2)^2 + K_4 (\sum\alpha^2{}_1\ \alpha^2{}_2)(\prod\alpha^2{}_1) + K_5 (\sum\alpha^2{}_1\ \alpha^2{}_2)^3 + K_6 (\prod\alpha^2{}_1)^2$**

**$4.5 = 2 + K_1/3 + K_2/27 + K_3/9 + K_4/81 + K_5/27 + K_6/729 = 125 + K_1/3 + K_5/27 + K_3/9 + K_4/81 + K_2/27 + K_6/729$ [re-arraging $K_2$, $K_5$**

⇨ **$27[9K_1 + 3K_3 + K_5] + [9K_4 + 27K_2 + K_6] = 2.5 * 729 = 1822.5$**

⇨ **$27 * 67 + 13.5 = 1822.5$**

⇨ **$[9K_1 + 3K_3 + K_5] = 13.5$….[ V];**

⇨ **$[9K_4 + 27K_2 + K_6] = 13.5$**

⇨ **$-3*9 + 27*1 + 13.5 = 13.5$**

⇨ **$K_4 = -3$; $K_2 = 1$; $K_6 = 13.5$**

⇨ **From[ IV ] - [ V];We have**

⇨ **$16K_1 + 4K_3 + K_5 = 64$**

**(-)**

**$9K_1 + 3K_3 + K_5 = 67$**

---

**$7K_1 + K_3 = -3$**

⇨ **$7* -1 + 4 = -3$;**

⇨ **$K_1 = -1$; $K_3 = 4$;**

⇨ **$K_5 = 67 - 3*4 + 9*1$**

⇨ **$K_5 = 64$**

**Substituting , $K_0$, $K_1$, $K_2$ $K_3$, $K_4$, $K_5$, $K_6$** ,in standard equation, we have **$Y^* = K_0 + K_1 (\sum\alpha^2{}_1\ \alpha^2{}_2) + K_2 (\prod\alpha^2{}_1) + K_3 (\sum\alpha^2{}_1\ \alpha^2{}_2)^2 + K_4 (\sum\alpha^2{}_1\ \alpha^2{}_2)(\prod\alpha^2{}_1) + K_5 (\sum\alpha^2{}_1\ \alpha^2{}_2)^3 + K_6 (\prod\alpha^2{}_1)^2$**

**$K_0=2$, $K_1= -1$, $K_2=1$; K3= 4; $K_4= -3$; $K_5=64$; $K_6 = 13.5$**

**$J^*_{Sr0.8K0.2Fe2As2} = 2 - 1(\sum\alpha^2{}_1\ \alpha^2{}_2) + 1 (\prod\alpha^2{}_1) + 4(\sum\alpha^2{}_1\ \alpha^2{}_2)^2 - 3(\sum\alpha^2{}_1\ \alpha^2{}_2)(\prod\alpha^2{}_1) + 64 (\sum\alpha^2{}_1\ \alpha^2{}_2)^3 + 13.5(\prod\alpha^2{}_1)^2$ ……….[ VI ];**

⇨ **[ VI ] ABOVE IS GENERALISED ESTIMATION CRITICAL CURRENT DENSITY $J_c$ OF IRON BASED SUPERCONDUCTOR Sr0.8K0.2Fe2As2**

⇨ **BY AN EXPANSION INTO DIRECTION COSINES $\alpha_1, \alpha_2, \alpha_3$ WITH RESPECT TO THE CRYSTAL AXES**

⇨ **FOR <100> Directions, $J^*_{Sr0.8K0.2Fe2As2} = 2$**

⇨ **FOR <110> Directions, $J^*_{Sr0.8K0.2Fe2As2} = 2 - 1/4 - 6.8/16 + 1694.4/64 =$**

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⇨ **FOR <111> Directions, $J^*_{Sr0.8K0.2Fe2As2}$=2-1/3 + 1/27 +4/9 -3/81 + 64/27 + 13.5/729 = 26.9846364883 approx = 27**

⇨ **ABOVE VALUES,CONFORM TO THE STANDARD CRITICAL CURRENT DENSITY $J_c$ OF IRON BASED SUPERCONDUCTOR Sr0.8K0.2Fe2As2**

**IV. Calculation Texture Factor, of Iron Based Superconductor Sr0.8K0.2Fe2As2 Of An Expansion Into Direction Cosines $\alpha_1,\alpha_2,\alpha_3$ With Respect To The Crystal Axes**

$A^* = K_0 + K_1 (\sum\alpha^2_1 \alpha^2_2) + K_2 (\prod\alpha^2_1) )+ K_3 (\sum\alpha^2_1 \alpha^2_2)^2 + K_4 (\sum\alpha^2_1 \alpha^2_2)(\prod\alpha^2_1) + K_5 (\sum\alpha^2_1 \alpha^2_2)^3+ K_6 (\prod\alpha^2_1)^2$

**From literature we have, Relation Between Texture Factor and Critical Current Density,$J_c = A^{1.5} \Rightarrow A = J_c^{0.667}$ (Approx)**

| S.No | Crystallographic Directions | Critical Current Density,Jc ( $*10^4$) | Texture Factor( *465.586093523) | Magnetic Anisotropy Energy Density of iron E*=0.355A*-1.898 |
|---|---|---|---|---|
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| 2. | <110> | 1.9 A/cm$^2$ | 1.534 | -1.3543 |
| 3. | <111> | 27 A/cm$^2$ | 9.009 | 1.300195 |

**DISCUSSION:**

The <110>//ND fibre accounts for the lowest anisotropy energy since the flux lines, distributed homogenously in a plane of the rotating laminated sheet, have an easiest magnetization direction with the in-plane rotated cube texture components. On the contrary, the <100>//ND,<111>//RD fibre orientations have relatively high anisotropy energy and as such, the occurrence of these components in pure iron is undesirable.

**$A^*_{[100]} = K_0 = 4.2$;**

For <110> directions, $\alpha_1 =1/\sqrt{2}$, $\alpha 2 =1/\sqrt{2}$, $\alpha_3=0$

Using [ II ] , in Standard Equation

**$1.534= K_0 + K_1 (\sum\alpha^2_1 \alpha^2_2) + K_2 (\prod\alpha^2_1) + K_3 (\sum\alpha^2_1 \alpha^2_2)^2 + K_4 (\sum\alpha^2_1 \alpha^2_2)(\prod\alpha^2_1) + K_5 (\sum\alpha^2_1 \alpha^2_2)^3+ K_6 (\prod\alpha^2_1)^2$**

⇨ **$1.534= 4.2+ K_1/4 + K_3/16 + K_5/64$**

⇨ **$[16K_1+ 4K_3 + K_5] = -170.624$……..[ IV ];**

For <111> directions, $\alpha_1 =1/\sqrt{3}$, $\alpha 2 =1/\sqrt{3}$, $\alpha_3=1/\sqrt{3}$….[ III ];

Using [ III] , in Standard Equation

**$J^* = K_0 + K_1 (\sum\alpha^2_1 \alpha^2_2) + K_2 (\prod\alpha^2_1) + K_3 (\sum\alpha^2_1 \alpha^2_2)^2 + K_4 (\sum\alpha^2_1 \alpha^2_2)(\prod\alpha^2_1) + K_5 (\sum\alpha^2_1 \alpha^2_2)^3+ K_6 (\prod\alpha^2_1)^2$**

**$9.009 = 4.2+ K_1/3 + K_2/27+ K_3/9+ K_4/81+ K_5 /27+ K_6 /729 = 125 + K_1/3 + K_5/27+ K_3/9+ K_4/81+ K_2 /27+ K_6 /729$ [re-arraging $K_2$, $K_5$**

⇨ **$27[9K_1+ 3K_3 + K_5] +9[K_4+ 3K_2 + K_6]= 4.809* 729 = 3505.761$**

⇨ **27 * 129+9 * 2.529 = 3505.761**

⇨ **$[9K_1+ 3K_3 + K_5] =129$….[ V];**

⇨ **$[K_4+ 3K_2 + K_6]= 2.529$**

⇨ **-1+3*1+0.529= 2.529**

⇨ **$K_4 = -1$; $K_2=1$; $K_6=0.529$**

⇨ **From[ IV ] - [ V];We have**

⇨ **$16K_1 + 4K_3 + K_5 = -170.624$**

**(-)**

**$9K_1 + 3K_3 + K_5 = 129$**

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**$7K_1 + K_3 = -299.624$**
⇨ **7* (-42) -5.624= -923.8;**
⇨ **$K_1 = -42; K_3 = -5.624$;**
⇨ **$K_5 = 129+3*5.624+9*42$**
⇨ **$K_5 = 523.872$**

**Substituting , $K_0$, $K_1$, $K_2$ $K_3$, $K_4$, $K_5$, $K_6$** ,in standard equation, we have **$Y^* = K_0 + K_1 (\sum\alpha^2_1 \alpha^2_2) + K_2 (\prod\alpha^2_1) + K_3 (\sum\alpha^2_1 \alpha^2_2)^2 + K_4 (\sum\alpha^2_1 \alpha^2_2)(\prod\alpha^2_1) + K_5 (\sum\alpha^2_1 \alpha^2_2)^3 + K_6 (\prod\alpha^2_1)^2$**
**$K_0=4.2$, $K_1= -42$, $K_2=1$; $K3= -5.624$; $K_4= -1$; $K_5=523.872$; $K_6 =0.529$**

**$A^*_{Sr0.8K0.2Fe2As2} = 4.2 -42 (\sum\alpha^2_1 \alpha^2_2) +1 (\prod\alpha^2_1) -5.624(\sum\alpha^2_1 \alpha^2_2)^2 -1 (\sum\alpha^2_1 \alpha^2_2)(\prod\alpha^2_1) + 523.872(\sum\alpha^2_1 \alpha^2_2)^3 + 0.529(\prod\alpha^2_1)^2$ ……….[ VI ];**
⇨ **FOR <100> Directions, $A^*_{Sr0.8K0.2Fe2As2} = 4.2$**

⇨ **FOR <110> Directions, $A^*_{Sr0.8K0.2Fe2As2}$= 4.2 -42/4 -5.624 /16 +523.872/64 = 1.534**

⇨ **FOR <111> Directions, $A^*_{Sr0.8K0.2Fe2As2}$=4.2 -42/3 + 1/27 -5.624/9 -1/81 + 523.872/27 + 0.529/729 = 9.00319478738 approx = 9.009**

## III Conclusion.
Critical Current Density $J_c$ and Texture Factor Of Iron Based Superconductor FeSe0.5Te0.5 can be expressed By an Expansion into Direction Cosines $\alpha_1$, α2, α3 With Respect To the Crystal Axes. Generalized equation of Critical Current Density $J_c$ Of Iron Based Superconductor FeSe0.5Te0.5 can be utilized to obtain its value at any crystallographic direction with the provision of directional cosines $\alpha_1$, α2, α3 along that particular crystallographic direction.

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