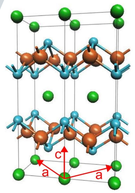
Strong Flux Pinning caused by Topographic Characteristics in (Ba, K)Fe_2As_2 Films

Myeong Jun Oh[a], Hyeong Jun Lim[b], M.S. Seo[c], S.Y. Park[c], Won Nam Kang[b] and Youn Jung Jo[a]

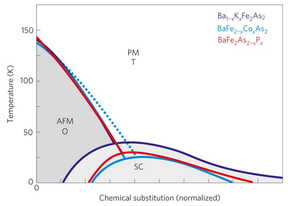
[a] *Kyungpook National University, Daegu, Korea* [b] *Sungkyunkwan University, Suwon, Korea* [c] *Korea Basic Science Institute, Daejeon, Korea*

We have reported that the strong flux pinning of (Ba, K)Fe_2As_2 thin films is induced by superconducting phase distribution characteristics. Depending on the growth conditions, our thin films have a diverse distribution which can induce various superconducting properties. The activation energy is one of the parameters that represent the pinning forces. We have compared the activation energy of two different distributions which have temperatures of 16780 K and 5900 K, respectively. The higher activation energy sample formed a mesh-textured distribution which had a delta-Tc pinning mechanism while the lower activation energy sample had an intrinsic pinning mechanism. Moreover, these distributions were achieved by EPMA elemental mapping which was modified by the overlay method. Therefore, we conclude that the superconducting phase distribution is strongly related to the flux pinning potential in the (Ba, K)Fe_2As_2 films.

(Ba,K)Fe_2As_2

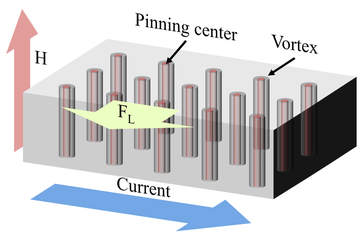


Crystal structure
[Jiun-Haw Chu, Stanford University, (2012)]



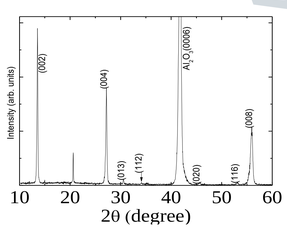
Phase diagram of $BaFe_2As_2$
[Nature Physics **6**, 645 (2010)]

Activation Energy



Lorentz force on the flux
[Smart Mater. Struct. **22** 035008 (2013)]

Sample preparation



XRD of (Ba, K)Fe_2As_2 film

Ex-situ Synthesis

✓ **Target**

Mixed powder Ba(99%), Fe(99.999%), As(99.999%) = 0.6:2:2.4 Sealed ampoule is annealed at 900 °C for 12 hours
Re-grinded sample is annealed at 900 °C for 8 hours

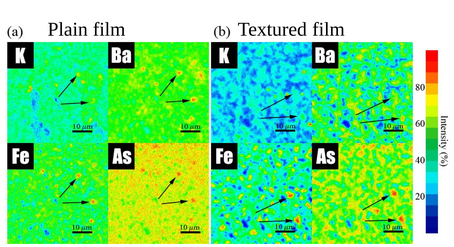
✓ **Precursor film deposition with PLD**

KrF Excimer LASER pulse(2000 times) on AO(0001) substrate

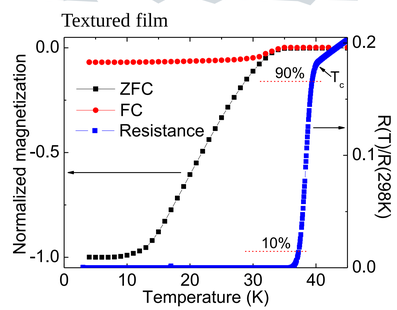
✓ **Potassium intercalation**

precursor film with potassium rump in an annealed at 700 °C for 2 hours

EPMA Elemental mapping



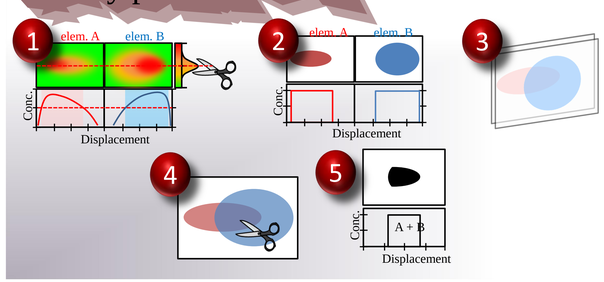
Results & Discussions

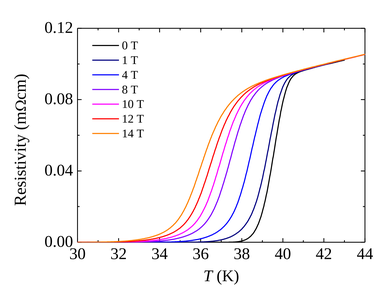


	Plain	Textured
K (at %)[(a)]	36.58	52.63
T_c (K)	39.3	39.2
ΔTc (K)[(b)]	2.06	1.35
RRR[(c)]	6.11	5.09
U_0/k_B(H//c, @0.1T) (K)	5951	8352

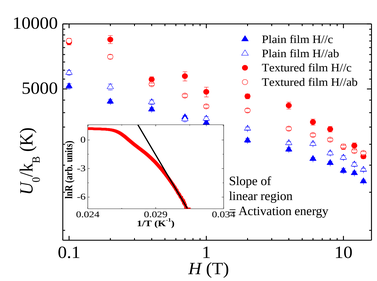
(a) achieved by EPMA
(b) $\Delta Tc = T_{c\_90\%} - T_{c\_10\%}$
(c) RRR = R(298K)/R(Tc)
*U_0/k_B of Single crystal: 9700 K [6]

Overlay process



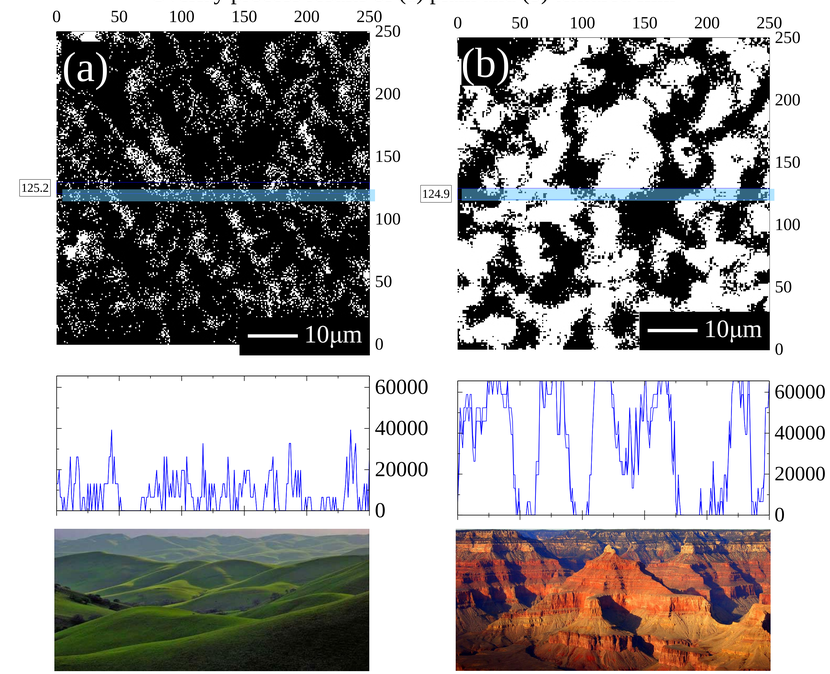


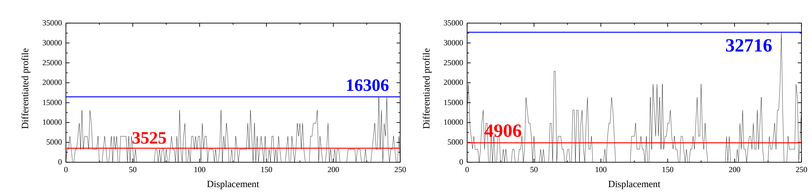
R-T curves at various *H*



Activation energy of (Ba, K)Fe_2As_2 films

Overlay process results of (a) plain and (b) textured film





Differentiated profile and its average value

$$F_p = \eta LD\left(\frac{(H_{c2}-H)\Delta k}{2.32k^3}\right)/x$$

η: efficiency factor
L: total length of flux line per unit volume
D: Dimensional factor of pinning mechanism
k: Ginzburg-Landau parameter
x: effective range of pinning interaction