

$F_p(H)$ plot is used for pinning evaluation of LTS

✚ **Volume (Bulk) pinning force**, F_p (N/m^3) = $J_c \times B$

- ✓ Higher F_p is the larger the current-carrying capacity
- ✓ F_p is determined by **the density and strength of the elementary pinning force**, and by **the forces between vortices**.

*Meingast and Larbalestier

J. Appl. Phys., Vol. 66, No. 12, 15 December 1989

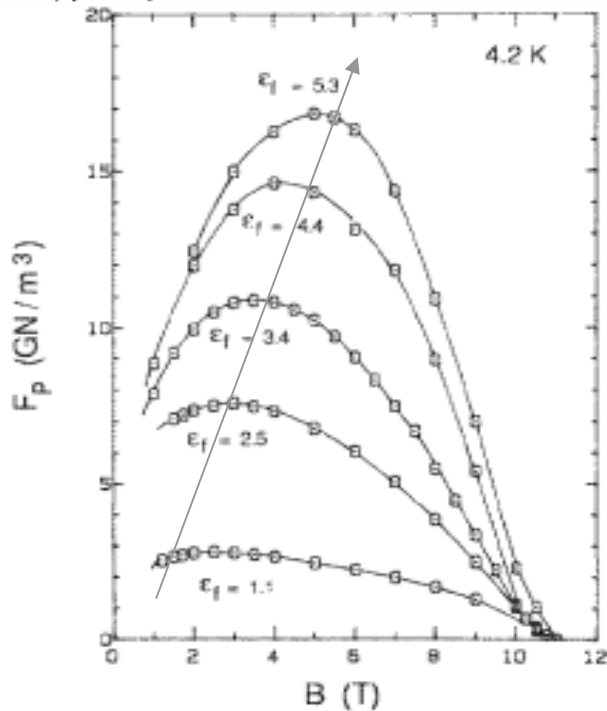
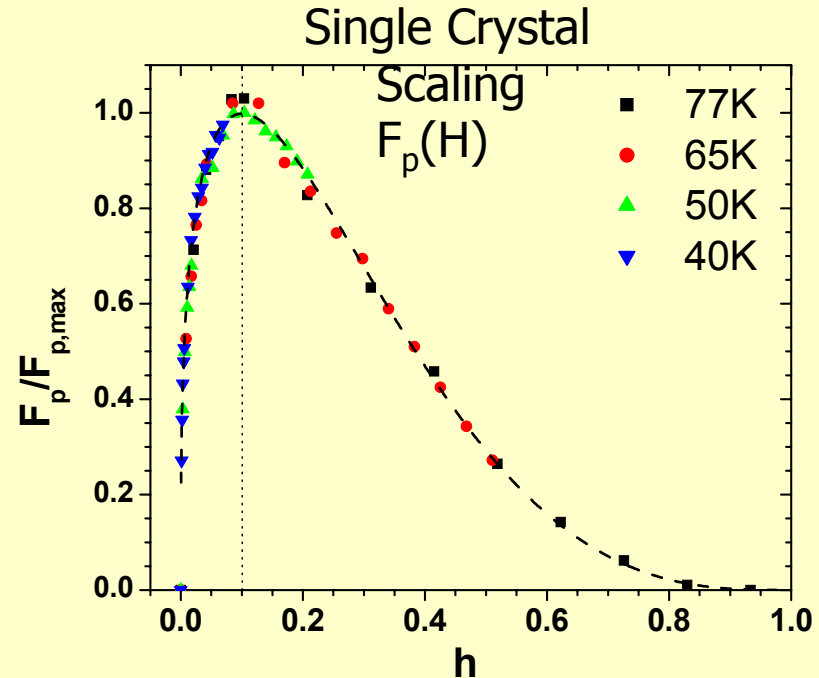
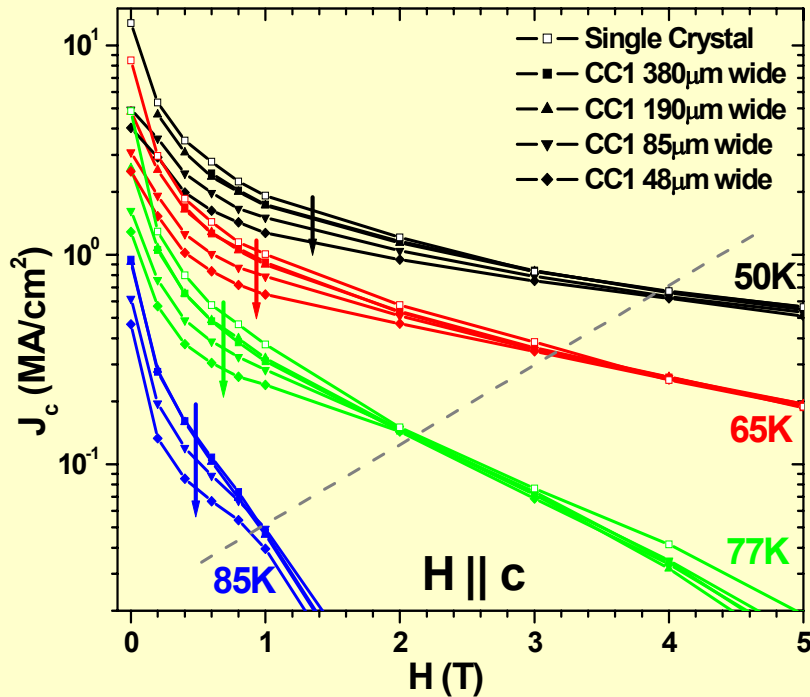


FIG. 4. Bulk pinning force (F_p) at 4.2 K, as a function of applied field, for all samples measured. The increase in F_p with increasing strain is evident.

- ✓ As pinning centers become more effective and increase in density;
 - ✓ The **magnitude of F_p** increases
 - ✓ The **peak maximum shifts** to higher field
- ✓ Example of **Nb-Ti** on left $F_p(H)$ plots
 - ✓ As strain, ϵ_f , increases, the pinning centers become smaller in size, thus, more effective, and the density of pinning centers increases
 - ✓ $F_{p,\max}$ increases and peak maximum shifts to higher field

✚ F_p peaks at $\sim 0.45H^*$

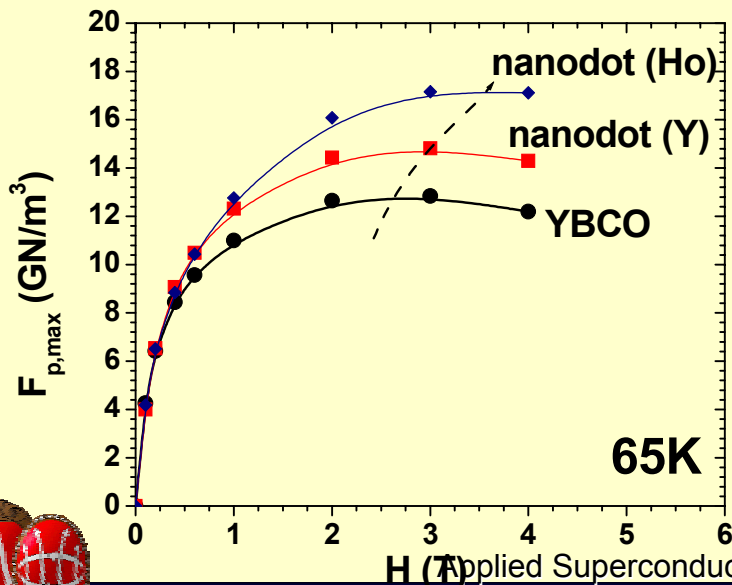
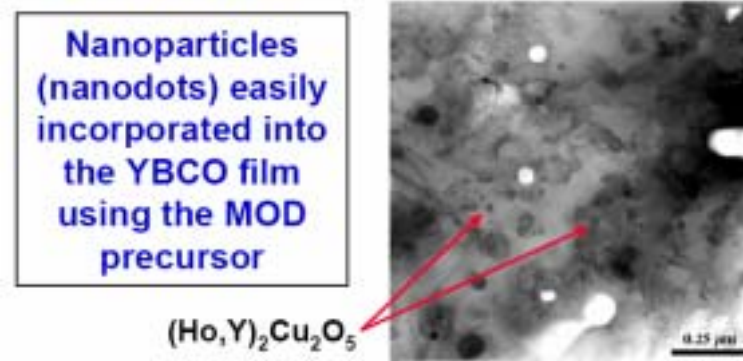
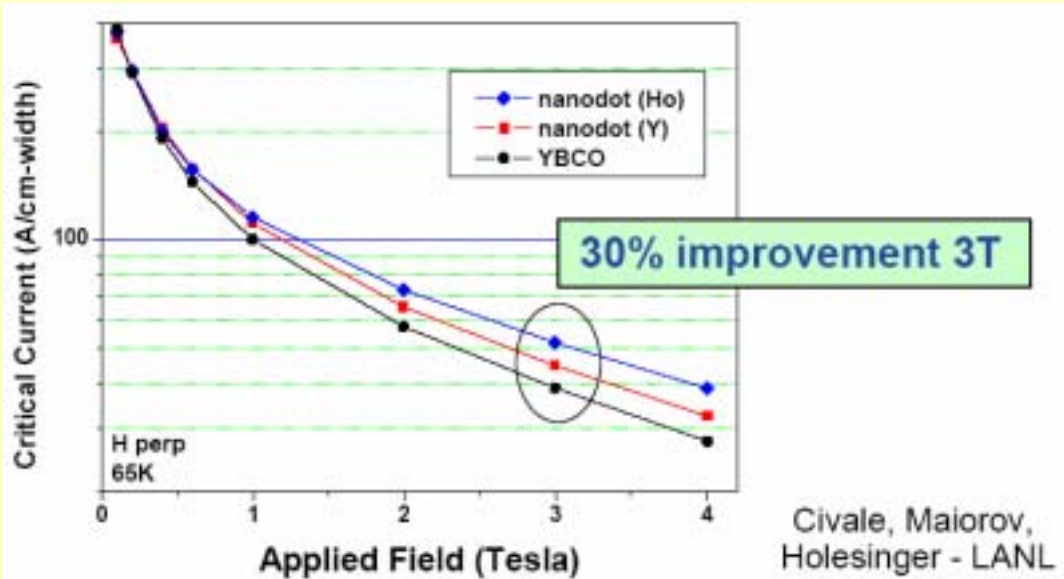
AMSC YBCO CC – RABiTS vs. Single Crystal Films



Standard AMSC single crystal MOD without extra pinning centers - F_p peaks at $\sim 0.1H^*$



Ho-doped MOD YBCO on RABiTS - AMSC

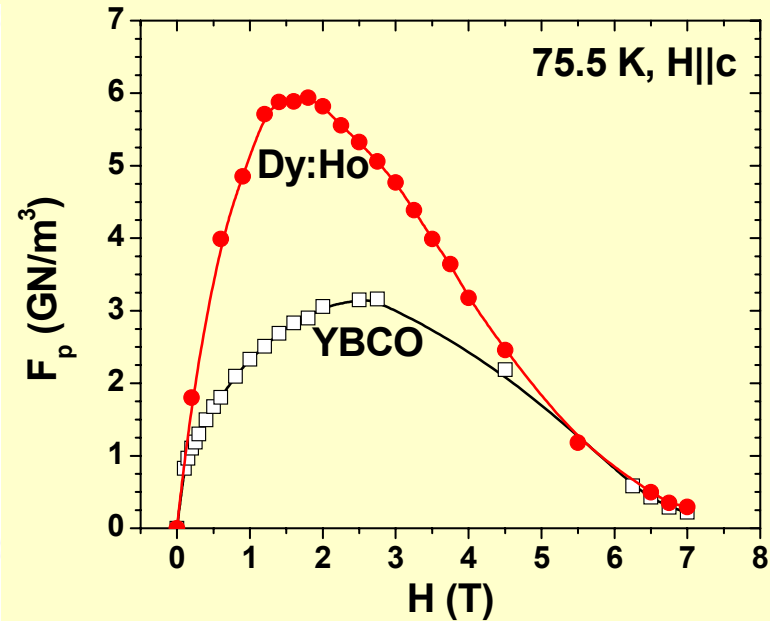
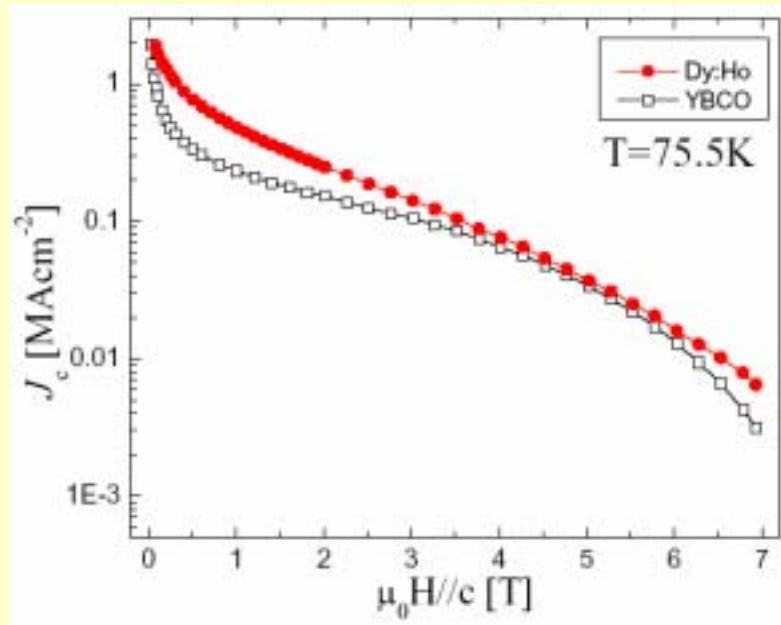


- $F_{p,max}$ increased in Ho-doped sample by factor of ~ 1.5
- The **peak shifted** to high field a little bit from ~ 2.5 to ~ 3.5 T

→ Suggesting effective pinning of **high density Ho nonodot** even respect to the field



Dy_{1/3}Ho_{2/3}-123 – J. L. Driscoll (Appl. Phys. Lett. 84, 2004)



- ✚ $F_{p,max}$ increased as Y substitute with Dy:Ho by factor of 2
- ✚ However, the peak shifted to low field from ~ 2.5 to 1.5 T

→ **Dy:Ho substitution** induces more effective pins, however, the density may not be enough to improve field performance !!!

